STOCHASTIC SIMULATIONS OF LONG-RANGE FORECASTING MODELS FOR LESS DEVELOPED REGIONS

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13. ABSTRACT

This ~~Interim~~ Technical Report describes progress made to date on the development of methodologies for long-range forecasting of five central environmental descriptors--national power base, international trade, international alignment, internal instability, international conflict--for the less developed regions of Africa, Latin America, and the Middle East. The report describes (1) the regions used in the analysis and their membership; (2) the strategic importance of the regions; (3) the differences between the regions and the developed nations (Europe) that required (a) reoperationalization of the central environmental descriptors and their predictors and (b) the structuring of the forecasting model; and (4) estimation techniques to be used to generate forecasting parameters to be used in stochastic simulations.

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STOCHASTIC SIMULATIONS OF LONG-RANGE FORECASTING MODELS FOR LESS DEVELOPED REGIONS

Interim Technical Report

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PREFACE

This Interim Technical Report describes CACI's progress to date on developing and applying long-range forecasting models to three less developed regions. The research which began in March 1975 is supported by the Defense Advanced Research Projects Agency, Contract No. MDA 903-75-C-0179, entitled "Stochastic Models for Long-Range Forecasting."

For the past two and one-half years CACI has been engaged in an effort to enhance forecasting capabilities within the Department of Defense (CACI, 1973, 1974). In particular, that effort has sought to improve the long-range forecasting capability in the Department of Defense by applying social science research methodologies to the problem of forecasting important economic, political, military, and social variables over the long range. The forecasts that have been produced so far have been direct inputs into the Joint Long-Range Strategic Study (JLRSS), prepared by JCS/J-5. During the first phase of this effort, CACI developed three single-equation models to forecast three key concepts (international conflict, international alignment, and domestic stability) for 20 Indian Ocean countries. On the basis of the results of this study, a second phase was planned and completed. In this subsequent effort, a more complex 12-equation model was constructed for Europe to forecast five central environmental descriptors for the European long-range environment. The five key concepts were international conflict, international alignment, international trade, internal instability, and national power base.

The purpose of the current project is to provide the Defense Community with high quality forecasting models for Africa, Lating America, and the Middle East. Toward this end, a number of specific accomplishments that contribute to the overall goal of the study should be mentioned.

- Three less developed regions have been defined in consultation with JCS/J-5 personnel and the members of each region have been specified (see Appendix 1).

- The set of forecast variables has been expanded and modified to take into account substantive regional peculiarities of both the lesser developed regions and the five broad forecast concepts.

- A new approach to measuring alignment has been developed in which arms flows, trade, aid, and U.N. voting are included in order to capture the complexities of international political orientations in the less developed regions. Also included is a measure that takes alignment incongruities into account.

- Several national power variables have been added to capture more realistically the complex processes of economic, political, and social development.

- Turmoil has been defined in terms that better represent popular discontent and unrest in Third World countries and a coup propensity indicator has been developed to measure the extent to which a country is prone to irregular government change.

- A Tension Ratio variable has replaced dyadic conflict frequencies to represent the propensity for military conflict among less developed countries.

- A set of 21 theoretical forecasting equations has been developed in consultation with JCS/J-5 personnel.

- A set of exogenous predictor variables, including arms transfers, trade, foreign aid, and military aid, have been included in the variable set. This improvement permits the analyst to move from assumptions about no change in outside influences to the point where various assumptions about the impact of outside influences can be examined.

OBJECTIVES OF THE CURRENT STUDY

The first and foremost goal of the current effort is to develop methodologies that can be useful in preparing medium and long-range defense policy and plans. The methodologies consist of the techniques of econometrics, simulation, and statistical analysis. Each approach is applied with an eye toward developing high quality forecasting models useful in preparing future defense policy and plans that will be included in the Joint Long-Range Strategic Study (JLRSS). Toward this end, CACI is developing medium- and long-range forecasting models for three less developed regions that are:

- Region-specific. The substantive peculiarities of each region are taken into account in the specification of the forecasting equations and the parameters that drive the forecasting models are determined for each region.
- Capable of capturing the volatility and individuality of the less developed nations in each region.
- Capable of representing the impact of U.S. and Soviet behavior and policy on the future African, Latin American, and Middle Eastern environments.
- Dynamic. The equations themselves and the forecast variables specifically deal with change and the output from the forecasting model will permit an assessment of the rapidity of change on a variable as well as the analysis of specific nation profiles across all variables.

These innovations will provide JCS/J-5 with a forecasting capability tailored to its specific needs regarding the development of long-range estimates of strategic plans and requirements. In addition, they permit hypothetical policy choices by the United States to be evaluated in an experimental setting by giving the analyst the capability to alter the U.S. and Soviet roles in the less developed regions. In this way, the impact of U.S. and Soviet behavior on the Third World regions can be better understood.

PROGRESS TO DATE

The following four tasks were considered necessary for meeting the objectives of the project.

Task 1. Identify Key Variables for Forecasting Other World Regions

In consultation with JCS/J-5 personnel, select three additional world regions for the development of long-range environmental forecasting models. Two subtasks are included in Task 1:

Subtask A. Identify Key Concepts

Identify, in consultation with JCS/J-5 personnel, a set of key concepts for inclusion in the forecasting model for each of the three regions.

Subtask B. Develop Operational Measures

Develop operational measures for each of the key concepts selected in Subtask A.

Task 2. Devise Structural Equations

Develop theoretical forecasting equations for the three regions selected in Task 1. Under Task 2, two subtasks are included:

Subtask A. Establish Relationships Among Key Variables

Establish linkages among key variables that form the heart of the forecasting models.

Subtask B. Identify Exogenous Predictor Variables

Identify, where appropriate, exogenous predictors of the key variables for inclusion in the forecasting models.

Task 3. Estimate Model Parameters

Estimate parameters for each forecasting model using techniques appropriate to the particular structure of each model. This task includes the collection of data on the operational measures of key concepts and on predictor variables.

Task 4. Develop Stochastic Simulations of the Forecasting Models

Develop long-range forecasts of the key concepts identified in Task 1. In this effort, probability distributions of key variable values will be derived and the models made sensitive to analyst inputs.

So far, CACI has completed Tasks 1 and 2 and has begun work on Task 3. During Task 1, the regions of Africa, Latin America, and the Middle East were identified as highly relevant to JCS/J-5 interests regarding strategic policy and planning over the next 20 years. It was determined that each area (for reasons to be elaborated in the text of this report) presented the United States with important challenges with strategic implications.

Task 1 also called for the operationalization of the key environmental descriptors for each region. This subtask has also been completed. While the broad concepts to be forecast are the same as those used in the European model -- national power base, domestic instability, national trade, international alignment, and international conflict -- important changes were made during this task for four of the key concepts. First, the alignment concept was enriched to account for arms flows, trade, and aid from developed to developing nations. Additionally, instabilities in nations' alignment behaviors were also included in the IDC regional models.

Second, because of the complex processes of economic, political, and social change in these three Third World regions and the effects of development on political stability, significant changes were made to the set of forecast variables for the national power base concept. A number of national power variables were added to enrich this sector that include private consumption, government and private investment, literacy rates, non-agricultural employment, and urbanization. These additional variables will permit the model to monitor more effectively the development process and to identify differential rates of development across various dimensions in each region. This latter capability, in turn, should permit forecasting of internal strain and tension in Third World countries that derive from economic imbalances and often result in violence.

Third, the domestic instability concept was improved. A coup propensity variable was added because this phenomenon is relatively infrequent in the European region but both frequent and significant in the three less developed regions. The turmoil variable was redefined to better represent popular unrest within Third World countries and to permit the use of more theoretically grounded relationships for forecasting domestic instability.

The set of forecast variables was also altered for the international conflict concept. Because of a scarcity of data for the three regions under examination, the dyadic conflict variable was dropped from this set. A supplementary variable, tension ratio, was added to take into account the greater frequency of international military conflict within the Third World, particularly in Africa and the Middle East.

Task 2, which called for devising structural equations and identifying exogenous predictor variables for the long-range environmental forecasting model, has been finished. Presently, a preliminary set of 21 equations has been constructed from relevant theoretical and substantive regional literature, and has been put into a form that is consistent with the requirements of a long-range forecasting model.

Exogenous predictor variables that are directly manipulable within the model have been identified. The variables (U.S. and Soviet arms transfers, military aid, foreign aid, cooperation and conflict behavior) provide a capability for altering the forecast environments of Africa, Latin America, and the Middle East. By developing the general forecasting equations this way, JCS/J-5 analysts can forecast alternative futures that reflect policy decisions by the superpowers which impact on defense policy and objectives, research and development, contingency planning (strategic and tactical), logistics, manpower and training.

In addition to specifying the linkages among the equations in the model during Task 2, CACI has devoted considerable effort to structuring the equations in a way that focuses on each forecast variable's rate of change in addition to particular point forecasts. Thus, the forecasting model will yield forecasts that reflect the growth or stagnation of respective LDC's in the regions and will permit accelerating or decelerating forces to be evaluated.

CACI is currently performing the steps necessary for timely completion of the remainder of the tasks delineated in the contract. These steps include refinement of the model structure, parameter estimation and other required data analyses, programming of the forecasting models, and preparation of the Final Report. During July, parameter estimation itself will continue while the forecasting model is being programmed. During August and September the models will be simulated to produce forecasts of the variables identified above and to generate distributions of key variable values. Finally, the Final Report will be in preparation from August through the end of October.

CHAPTER SUMMARY

This Interim Technical Report describes the interactive forecasting models for the three less developed regions. Chapter 1 reviews the changing impact of U.S. and Soviet influences on Africa, Latin America, and the Middle East, and the importance of the less developed countries

to long-range strategic interests. Chapter 2 presents an overview of the LDC model and elaborates the rationale behind the changes that have been introduced. Chapter 3 describes each of the specific forecasting models. Chapter 4 provides an overview of the parameter estimation techniques: ordinary least squares and two-stage least squares. The report concludes with a statement of progress to date and the anticipated scheduling of the steps necessary for the timely completion of the project.

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CHAPTER 1: DYNAMIC MODELING OF AFRICA, LATIN AMERICA, AND THE MIDDLE EAST

PURPOSE AND STRUCTURE

The purpose of this chapter is to establish the rationale for forecasting the future environment of the less developed regions of Africa, Latin America, and the Middle East. Here the importance of understanding the future environments and their implications for defense policy and planning is discussed. The chapter is divided into three major sections:

- The importance of medium- and long-range forecasting for defense policy and planning.
- The changing international environment and the impact of U.S. and Soviet policies (past and present) on the three developing regions.
- The strategic importance of the three regions in political, economic, and military terms and the significance of these three areas as they impact on planning for meeting military objectives for the next 20 years.

Any systematic analysis of the economic, social, and political trends of the nations and regions of the world that can be employed to cast light on conditions that might affect future military posture is of immense value for the DoD planner. Thus, this chapter places the greatest emphasis on three themes.

- The less developed nations <u>have</u> strategic importance.
- The less developed nations are changing and the changes have implications for U.S. interests.
- The future conditions in the regions of Africa, Latin America, and the Middle East must be understood by JCS and the most advantageous means to securing accurate and useful foreknowledge of those conditions is through systematic, long-range forecasting.

Forecasting for Policy Planning

Planning activities in the Department of Defense invariably rest upon assumptions about the nature of the environment for which preparations are being made. Systematic planning requires:

- A clear statement of the planner's goals and objectives;
- Assumptions about the characteristics of the present and future environment, stated in terms of these goals, objectives, and current policy:
- A set of alternative plans or policies;
- Assumptions about the characteristics of the present and future environment, stated in terms of goals, objectives, and alternative plans or policies.

The second and fourth of these planning elements, however generated, are forecasts. All planning activities are based on forecasts of the environment that consider the implementation of alternative policies, one of which can be no change in policy. Often the forecasts are implicit statements of expectations, unsystematically generated, whose assumptions remain obscure and cannot be verified. Quantitatively based forecasts, on the other hand, are built on systematic statements of assumptions. Therefore, the plans developed from them can be subject to critical study and evaluation in an experimental environment. Hence, they can provide a base for selecting optimal policy programs. Department of Defense planning programs are designed to deal with some finite set of contingencies that are either probable or improbable but would have severe adverse consequences for this country. This type of planning, usually termed contingency planning, is based upon a projected international environment with which the United States may be confronted in the future. Once a range of likely futures has been defined, force structure, deployment plans, and so forth can be developed to maximize the likelihood of attaining U.S. goals and objectives given their occurrence. Defining the range of likely futures requires characterizing, in some systematic way, the nature of the environments that may develop. This latter activity is called forecasting.

Another kind of planning which is especially important within the Department of Defense is acquisition planning, that is, determining needs for weapons procurement. Many hardware acquisitions of the Department of Defense have a very long life span. Major weapons and support systems, such as logistics and communications systems and command and control hardware, require about 10 years for development and are in use for another 20 years. Since these systems are intended for operation for 10 to 30 years from the beginning of development, they must be designed to meet future Department of Defense requirements. The identification of these future requirements, then, depends upon systematic description of the future environment in which DoD goals and objectives will have to be attained. As noted above, description of the future environment, either implicitly or systematically, constitutes forecasting.

Other requirements, unique to DoD, can also be cited. For example, basing agreements, like major weapons and support systems, often have a very long life span, sometimes as much as 100 years. As with weapons and support systems, basing agreements are arranged to fulfill specified DoD requirements, such as forward deployment for mobile air/ground forces or for intelligence activities. These requirements, in turn, stem from expectations that different types of functions will have to be performed in different parts of the world in the future. Forecasting the future international environment with a view toward anticipating shifts in alignment, changes in government, changes in development levels, and the propensity for overt violence can do much to aid in the formulation of future arrangements, such as forward development, overflight privileges, ally support, and basing agreements to cope with the changing international environments.

THE CHANGING INTERNATIONAL ENVIRONMENT

Analysis of post-World War II patterns of international conflict suggests that quarrels within and between nations have occurred for the most part in geographically distant locations. Currently, it appears that the distribution of the slowly diminishing resource base, particularly minerals and fuels, will become a more prevalent source of conflict among nations. And many of these resource-rich nations are in Asia, Africa, Latin

America and the Middle East. It is expected that conflicts will continue to occur (but perhaps for different reasons) and that the distribution of these conflicts around the globe will remain essentially unchanged. Given this trend, it is most likely that any involvement of the U.S. military will require rapid reaction and high mobility under constraints of limited resources. Operations, to ensure efficiency and promptness, may have to function in an international environment in which former allies have opted for increased political latitude that results in a dissolution of existing basing agreements and a denial of overflight rights. These contingencies must be prepared for if correct and timely decisions are to be made. The changing international environment also is expected to be characterized by increased polycentrism combined with growing economic interdependence.[1] Thus, the political and ideological proclivities that constituted international alignment in the 1950's and 1960's may no longer be interpretable as meaningful indicators of the real orientations of nations. Currently, the political and ideological commitments of governments are being supplanted by vested economic interests having to do with trade, economic growth, diminishing resources, and economic interdependence in general. Therefore, it is important that the interrelationships that are manifestations of these new developments be understood and that their implications for the future be clearly stated.

The loosening of bloc ties and the increasing interdependence of the nations of Asia, Africa, Latin America, and the Middle East are reflected in their international economic interactions with the superpowers and with each other.[2] Also, economic growth, leading to increased freedom of decision, may have an impact on choice of arms suppliers which, in turn, may reflect or result in their political realignment.

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[1] The growing importance of interdependence among nations is the subject of an expanding body of literature. See, for example, Meadows, et al. (1972), Brown (1975), and Mesarovic and Pestel (1974).

[2] Baerrensen, Carnoy and Grunwald (1965), Duncan (1972), Jenkins (1972), Bhagwati (1972), Ferguson (1972), Hunter and Reilly (1972), and Scott (1973) all discuss the impact of superpower behavior on the LDC's.

The atmosphere of detente between the United States and the Soviet Union and the United States and China continues as a paramount focus of foreign and military policy. To be sure, despite efforts and overtures toward peace, the threat of nuclear confrontation remains and must be considered in the development of any strategic policy and planning for preparedness. Yet these important developments cannot be permitted to obfuscate other situations and developments around the world that also have an impact on U.S. foreign and military commitments, policies, and plans.

In the less developed regions of Asia, Africa, Latin America Middle East, considerable social, economic, and political change has occurred in the late 1960's and early 1970's. These changes have important implications for the future military posture of the United States. Until now, the less developed countries have seldom appeared as significant military, political, or economic forces in the international context. Some of the larger, more powerful nations in Latin America have experienced substantial economic growth enabling them to assert their independence within the Western Hemisphere. As a result, some of them have turned away from the United States toward Europe, the Soviet Union, and Japan in search of trading partners and sources of military hardware.[3] In Africa, the emerging nations continue to experience domestic political and economic problems that undermine progress. Africa's problems threaten to deny to the United States strategic raw materials and markets for its goods and raise questions about their commitments. In the Middle East tensions between Israel and the Arab nations and within the Arab bloc continue unabated. At the same time, the economic growth of the oil-rich nations has enabled them to invest their new-found wealth in the development and improvement of their respective militaries. The constant threat of war in the Middle East makes the region and U.S. policy toward them of capital importance for the United States, particularly DoD and JCS.

The above discussion demonstrates the importance of the nations of Africa, Latin America, and the Middle East. Changes within these countries and

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[3] Duncan (1972), Goldhammer (1972), and Theberge (1974).

in American, Soviet, Chinese, Japanese, and European policies toward these nations will have important influences on the future strategic roles these nations will play. By forecasting the important trends within the less developed nations expected to emerge over the next 20 years, their implication can be better understood. These implications of ongoing changes can be incorporated into future strategic policy and planning.

The current study involves the application of quantitative methods for constructing long-range forecasting models for the regions of Africa, Latin America, and the Middle East.[4] The forecasting models will enable each region to be studied over time to identify future developments with important implications for U.S. military planning. The model being developed explicitly includes many of the salient features of the relationships between the LDC's and the more developed world (aid, trade, arms transfers). Some of the variables have been measured in a way that will allow specific U.S. policy choices to be mapped onto the future. In this regard, they will enable JCS/J-5 to develop alternative forecasts for assessing alternate policies and requirements.

STRATEGIC IMPORTANCE OF THE LESS DEVELOPED REGIONS

In this section the three regions--Africa, Latin America, and the Middle East--are analyzed from a politico-ideological, economic, and military perspective, respectively. It should be pointed out that these categories do not stand in isolation from one another. Contemporary societies, be they less developed or developed, are invariably complex. Thus, politics and economics are inextricably linked, as are politics and military policy. Not only are these sectors linked within nations, but they are linked internationally. Therefore, our categories represent simplifications of the domestic and international structures of the less developed regions used only for analysis.

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[4] See Appendix 1 for a list of less developed countries in each of the three regions.

AFRICA

Political and Ideological Significance

Upon receiving their independence, many African nations opted for non-alignment.[5] This position was based in part on the belief that neutrality would insure their independence and non-involvement in Cold War issues. As time passed, many of these African nations, realizing the importance of international interactions for growth, became increasingly involved in international organizations, especially the United Nations.

Today many African states are viable actors in the international system. U.S. involvement in Africa has been primarily in the form of development assistance, technical assistance, and foreign aid. These programs have often been designed to maintain the friendship of the non-aligned. Foreign assistance programs have also been implemented by the Soviet Union and the People's Republic of China.[6] Thus, although the African nations remain ostensibly neutural, they are of considerable political value to the three superpowers. The importance of the African nations to the Soviet Union and the PRC stems from the Communist powers' desire to loosen the linkages between the African nations and the West and to encourage their identification with the world Socialist movement. Yet, the Western states see Africa as an important resource base for the long-term future and as an area where orderly societies based on democratic processes should be encouraged.

Economic Significance

The economic importance of Africa is basically twofold; the African nations are sources of strategic raw materials and their populations are potential

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[5] See Jansen (1966) and Alker and Russett (1965) for general descriptions of post-independence, non-alignment of the Afro-Asian nations.

[6] See, for example, Department of State (1966, 1971) and Duncan (1972).

consumers of U.S. products.[7] Internal or international disruptions on the continent can affect the United States both economically and militarily. Therefore, it is in the interest of the United States to understand in advance the potential for domestic and international conflict in those African nations where important economic interests are located. The long-range forecasting model is designed to include measures of the propensity for irregular executive transfers and domestic turmoil that should forecast potential domestic violence in that region. In addition, the model includes measures of dyadic trade and trade (both exports and imports) with the United States and the Soviet Union as measures of economic alignment with the two superpowers. Both of these concepts are important because they allow the stability of economic transactions and their impact on other sectors to be evaluated. If a nation shifts its alignment in the international economic sector, this movement can be measured over time. As these shifts occur, other variables in the model will be affected. Thus, the interactive form of the LDC model will enable the impact of economic and political change to be evaluated.

Military Significance

The U.S. military is presently involved in only five countries on the continent. This present involvement is primarily concerned with security assistance programs. U.S. military personnel, although limited in number, support communications facilities, function as military assistance advisors, support satellite tracking facilities, and serve as defense attaches.[8] Although U.S. military presence in Africa is very limited, the continent retains its strategic importance because of two geographic areas; the Indian Ocean littoral and the Republic of South Africa. In Eastern Africa, the coastal countries become more important as Soviet naval capabilities

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[7] Cartey and Kelson (1970) and Wallerstein (1961) provide a good general introduction to emerging Africa.

[8] Statement of General George S. Brown, Chairman of the Joint Chiefs of Staff before the U.S. Senate Armed Services Committee, February 7, 1975 p. 157.

are expanded in the Indian Ocean and as uninterrupted transport of oil from the Persian Gulf becomes imperative for the continued growth of U.S. industry. In the south, the Republic of South Africa remains important because of its proximity to the Indian Ocean and the Persian Gulf. The remainder of Africa is only moderately explored and developed, yet is rich in materials of considerable value to the technologically advanced economies of the West.

Forecasting the Changing African Environment

The African continent has been in a state of constant flux since the early days of independence. Although the nations of the region appear to have settled many of their disputes, border conflicts, tribal warfare, and domestic violence remain distinct possibilities. The nations of Europe that were the former metropoles of the African colonies remain economically influential. However, Russia and China have begun foreign assistance programs that include arms sales to some nations. Politically and ideologically, the African nations are subject to many influences and some have begun to openly embrace Socialism.

Africa is still beset by many political and economic problems and development has been very slow (Burke, 1964 and Green and Seidman, 1968). This is not to say, however, that change has not occurred. In spite of disagreements of national policy, some Black African nations have made overtures toward South Africa arguing that all African nations must cooperate to contribute to growth on the continent. The liberation of the Portuguese colonies means that only one colony, Spanish Sahara, still exists, and will gain its independence in the near future. Nigeria, now an exporter of oil, is already beginning to experience rapid growth and greater international influence. Ethiopia, a staunch ally of the United States since World War II and once a politically stable country, is currently suffering high levels of unrest. Change in Africa has and will continue to have both positive and negative effects on the United States and its allies. Whatever the direction, these changes can affect the strategic

capabilities of the United States both directly and indirectly. It therefore is of particular importance to construct forecasting models that can capture the complexity of the African regio l environment--the propensity for domestic and international conflict, th fluctuating alignment patterns, the role of the international economic sector, the political unrest, and the growing role of indigenous militaries in political affairs. These and other aspects of the African region involve the national interests of the United States and may require that specific decisions be made regarding their protection.

Forecasting provides the planner and decision-maker with foreknowledge of likely developments. In Africa, because of the great potential for international disruption, forecasting can be especially useful for systematizing the planner's understanding of the prevalent forces in the region and objectifying their interrelationships.

LATIN AMERICA

Political and Ideological Significance

The countries of Central and South America have always been important to the United States. The geographic proximity of the region to the United States makes it crucial for the maintenance of U.S. security. Recently, the Latin American nations have increasingly asserted their independence from the United States indicating determination to function as nonaligned actors in the international system.[9] Although some nations in the region have not experienced rapid growth, several influential countries in the region (Argentina, Brazil, Peru, Venezuela, and Mexico) are among the most rapidly developing countries in the world and have highly developed industrial economies. They have achieved sufficient economic and political significance to engage in international relations as independent forces.

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[9] Numerous references to Latin America's self-assertion can be found in contemporary literature on the area. See Ferguson (1972), Sunkel (1972), Scott (1973), Stallings (1972) and Furtado (1970).

They have embarked on policies involving the transfer of arms, international trade, and military growth and no longer rely on the United States.

Nationalism continue .c inspire political and economic change in the region.[10] Despite the low probability of conflict within the region, the Latin American nations continue to expend substantial amounts of money for defense. Argentina and Brazil are believed by some observers to already possess the basic necessities for developing nuclear weapons. Peru has made extensive arms purchases recently, including purchases from the Soviet Union (Brown, 1975: 139)

The role of the military in the Latin American countries is a significant factor in Latin American-U.S. relations. In some cases military leaders have been the proponents of policies of greater independence for their nations. In other cases military regimes have continued to support the concept of hemispheric alignment with the United States. The recent emergence of military regimes with a variety of different ideological positions is of great concern to the United States as it seeks to promote its own and hemispheric security interests.

Economic Significance

Nationalism colors much of the international and national economic activity in the Latin American region with anti-U.S. sentiment.[11] Because many of the Latin American countries are the more developed of the "developing" nations, they constitute promising markets for U.S. products. Furthermore, many nations of the region remain sources of raw materials of strategic importance whose denial to the United States would seriously affect U.S. military capability. Domestic political instability can

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[10] Lieuwen (1965), Petras and Zeitlin (1968), and Frank (1967) provide overviews of the impact of nationalism on the economic, political, and military sectors of the Latin American nations.

[11] See footnote 10.

affect U.S. economic interests directly, and the threat of nationalism of U.S. industries and other U.S. interests exists in several countries. The independent economic policies of Venezuela, Mexico, and Peru have affected U.S. relations with these countries and with other nations in the region.

It is easily seen that the economic significance of Latin America makes this area strategically important to the United States. Should the nations of the region, or even a subregional grouping, deny the United States access to its markets or restrict trading, military and economic interests would be threatened. Major political realignments would also be viewed as a threat to U.S. national security.

Military Significance

In the past, the United States has contributed much to improving the quality of the Latin American armed forces. Together, the United States and Latin American countries have engaged in joint exercises to improve both the combat and logistics capabilities of the participants. The United States has participated in security assistance programs with many of the countries in the region. Not only do joint and bilateral defense agreements exist, but material and training also represent U.S. investments for furthering U.S.-Latin American relations (Brown, 1975: 141-143).

Two issues of particular significance to U.S. strategic policy and planning should be mentioned here. The first is the situation in Panama regarding the Panama Canal. The uncertain future of U.S. jurisdiction over the Canal takes on critical importance due to its location on a key line of communication between the Atlantic and the Pacific Oceans. In addition, the Panama issue has become an important bone of contention between the United States and other Latin American countries. The second issue involves rapprochement with the Castro regime in Cuba. The reestablishment of relations with Cuba could have strategic implications for several reasons. First recognizing Castro's government might alleviate

tension between the United States and other Socialist regimes throughout the world. Second, U.S. recognition of Cuba would resolve a major issue dividing the United States and its Latin American allies and could improve hemispheric relations. Third, the reestablishment of relations with Cuba may indicate that U.S. policy toward leftist and independent regimes may be more tolerant in the future.

Forecasting the Changing Latin American Environment

As in Africa, change in all sectors characterizes the Latin American region.[12] As the Latin American nations grow economically, become more sophisticated technologically, and take their places as major actors within the Western Hemisphere, they become even more strategically important as allies of the United States. The manifold forces that impinge on U.S.-Latin American relations need to be understood. Economically, Latin America is a vast market for American products and a source of major raw materials. However, Latin America has been turning toward other regions for trading partnerships, arms, and development aid. Simultaneously, the influence of the United States in the region has diminished. Will this trend continue? Will alignment in the political arena follow alignment in the economic? What are the implications for shifts in international orientations on both international and domestic developments in the region?

Specific equations in the forecasting model allow these and other trends to be forecast. For example, the reestablishment of trade with the United States should have predictable consequences for the growth of the Cuban economy since, in the forecasting equations, trade and the growth in trade, both from the United States and the rest of the world, impact on a nation's economic sector.

Also the effects of increases and decreases in trade dependency on economic growth can be mapped over the long range. In turn, the impact of economic

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[12] See Lieuwen (1965), Chalmers (1972), Anderson (1967), and Needler (1968) for discussions of the effect that change is having on the social, economic, and political areas in the Latin American societies.

growth on defense spending resulting from either an increase or decrease in trade is ascertainable. And, as governments continue to divert government income away from domestic welfare spending to defense, either to enhance national security or suppress domestic violence, political discontent will threaten to disrupt the stability of many Latin American nations. These trends not only characterize this region but have implications for U.S. military posture and national security as well.

Foreknowledge of the propensity for domestic turmoil and coups, of defense spending trends, of uneven economic development, of shifting political and economic alignments, and of both rapid growth and stagnation can provide the defense planner with valuable insight into future policy demands and and decisions regarding Latin America. By providing systematic mappings of the evolution of the Latin American environment, long-range forecasting can enable the policy-maker to grasp the fundamental trends emerging in Latin America and use the forecasts to prepare better for military contingencies.

THE MIDDLE EAST

Political and Ideological Significance

The current major threat to international peace resides in the Middle East. The United States, by word and action, has affirmed its commitment to the survival of Israel. At the same time, the United States has demonstrated concern for the attitudes and interests of the other countries in the area. The United States depends to a large extent on Middle Eastern oil for industrial output, and the uninterrupted flow of oil to industry means a continuing supply and resupply of needed military items.[13]

[13] Mallakh (1970) and Hurewitz (1969b).

Both the United States and the Soviet Union compete covertly and overtly for influence in the Middle East.[14] The United States has made initiatives to increase cooperation with Iran and Saudi Arabia in a number of important areas.[15] The Soviet Union has made inroads into Egypt, Syria, and Iraq. These events have taken place before a backdrop of domestic unrest which continues to plague all nations in the region as they attempt to develop politically and economically.

As in Africa, the intent of the Soviet Union is to loosen existing ties between the Middle Eastern countries and the United States.[16] Thus, the Soviet Union has attempted to influence individual states politically and to enhance the transactions between it and the Arab members of the region. The United States has pursued similar goals, maintaining the relationships already established with key actors in the region. In this regard, the United States continues its efforts to enhance the security and development of the individual nations in the area with its military assistance programs and foreign aid.[17]

Economic Significance

The influx of petro-dollars into the oil-rich Middle Eastern countries has enabled them to invest substantial sums of money in industrial and economic development and to invest capital overseas. Revenue from oil exports being invested in Europe and the United States by the oil-rich nations furthers economic interdependence. Therefore, political and economic unrest in the region has obvious economic, political, and military implications in the United States. Any policy affecting the distribution of oil to the United States affects the strategic capability of this country. The limitations on oil have already brought about the reduction

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14 Berry (1972), Joshua (1971), and Hurewitz (1969a).

15 Ramazani (1972) and Burrell and Cottrell (1972).

16 Joshua (1971) and Safran (1969).

17 Brown (1975).

of training exercises, reduced production of propellants, some reorientation of research and development, and so on (Brown, 1975: 181-199). A complete oil embargo lasting for several months would have serious implications for the strategic capability of the United States.

Military Significance

The Middle East is militarily significant for the United States for two key reasons. First, it is a major source of petroleum and second its defense is an important U.S. commitment. Our official commitment to Israel generally involves supplying it with military hardware for defense. Thus, it is important that air and sealift capability and lines of communication to Israel be maintained. In this regard, the denial to the United States of air basing in Portugal, Greece, and Spain demands that logistics plans be revised if Israel is to be supported. The dependence of Western Europe on Arab oil has virtually eliminated that area for stationing supporting units and equipment. At the same time, the United States must recognize the importance of the Arab countries for maintaining its global strategic capability. It is imperative that this aspect of U.S. strategic policy not be ignored.

Forecasting the Changing Middle Eastern Environment

Although the Arab-Israeli conflict seems to be stalemated temporarily, the Middle Eastern region is at the crossroads of peace or war. Despite the consuming nature of the conflict, the area is in a state of flux like the developing regions. The new-found wealth of the oil-rich nations has spurred economic growth and attendant political change. The facilitating nature of international alignment in the region encourages Russian involvement in the area. In addition, the military capabilities of several Middle Eastern nations continues to grow apace and the arms race accelerates along with international tension.[18] Each of these features has been built into the forecasting model for the Middle Eastern region in an effort to map

[18] The change in military capabilities can be seen by comparing figures for defense expenditure in Hurewitz (1969b) to SIPRI (1971) and Tahtinen (1974).

developments in this area into the future. As nations grow they divert substantial portions of this growth into defense expenditures. In the Middle East, oil revenue contributes to the acceleration of military expenditure. Also, the United States and Soviet Union have provided weapons to all of the nations in the region.

The potential for international conflict in the Middle East is of such importance that any systematic analysis that can signal the outbreak of hostilities is justified. Forecasting the long-range Middle Eastern environment demands that several critical issues be incorporated into the model to represent accurately the complexities of the region. The Arab nations, because of the rapid influx of oil revenue, have the capacity for rapid growth and diversification. This means that the dependence of the region on oil can be used for capital investment projects that will reduce dependence and permit economic and industrial diversification. The diversion of oil revenue into other investments and a concomitant decline in trade dependence will mean greater decision-making latitude for the richer nations in the area. Growth in income has also been shown to be diverted into defense spending. The distribution of new-found wealth, therefore, can point to important developments in areas where the capacity for rapid growth is in evidence. The mapping of distribution trends over time, then, can provide useful information for understanding the potential military power of a nation.

Political alignment in the Middle East has also remained in a state of flux. Generally, the countries of the Middle East have mixed international orientations and even appear to be the most unstable LDC's regarding alignment. The current forecasting model includes a measure of alignment instability that, over time, should reveal the vacillatory nature of international alignment in the region. The model will allow forecasts of the probable future alignment of a nation as it attempts to resolve its alignment instability and the implications for such alignment on policy and planning in the strategic arena. For example, should a major exporter of oil to the United States resolve its alignment instability by moving

toward the Soviet Union, such a development should have implications for strategic policy. Consequently, the value of a Middle East forecast lies in its signaling of developments unfavorable to strategic plans as they rely on the natural resources of that region. With advance knowledge of the probability of such developments, alternative plans can be devised.

As the model is constructed, it also reflects the extent to which alignment impacts on domestic politics and economic development. Finally, the extent to which the United States and the Soviet Union cooperate, trade, extend military assistance, and distribute foreign aid to the countries of the region can be manipulated by adjusting individual variables to reflect policy changes. As a result, alternative futures can be forecast and the implications of these futures can be evaluated from the perspective of strategic policy and planning.

The implications of the propensity for domestic, political unrest, the vacillatory nature of international alignment, the disproportionate levels of defense spending, the potential for international conflict, the fantastic economic growth, and the threat to world peace that characterizes most of the Middle East make the region perhaps the most strategically important of the three less developed regions. In this regard, forecasting these and other trends becomes imperative if the impact of such developments for future military posture is to be adequately understood. The forecasts to be made from the Middle Eastern regional model will be an accurate representation of the key forces and their interrelationships in that area and will assist in the formulation of long-range policies and plans for the Middle East.

Summary

The three regions dealt with in the preceding discussion are marked by significant contrasts. Latin America is the most developed and Africa the least developed region. The Middle East, the region with the greatest potential for overt violence, possesses the potential for rapid growth due to

its vast oil resources. Each area is rather unstable politically and the threat of domestic violence is constant. However, the origins of such violence vary from region to region. In Latin America, the awareness of the benefits of economic growth leads to the realization of material wealth for the elite and a better quality of life for the mass of workers. Violence often erupts when a different balance between the two is sought. Disenchantment with the status quo has resulted in military coups in Latin America and Africa. However, in the latter region, political unrest has very diverse origins. International terrorism in the Middle East has both domestic and international implications and threatens peaceful progress in that region.

Internationally, the dependence on primary product exports characterizes Africa and Latin America although the latter region has been able to halt and in some cases reverse the importance of the international economic sectors of its nations. Trade in oil, of course, is the key to growth in the Middle East and oil constitutes a major weapon with which to confront the developed world. Dependence on trade has also varied effects and each region must be viewed as unique in this regard.

The emergence of Latin America in the 1800's and its proximity to the United States have enabled it to progress more rapidly than the other LDC regions. The availability of American capital and the interest of the United States in Latin America for national security aligned North and South America. This pattern, however, is changing as Latin America, on the strength of its economic potential, begins to assert itself. In Africa, dependence on Europe for development assistance and certain markets is giving way to increased penetration (ideological and economic) by Russia and China. And, in the Middle East, the Russian presence is well documented.

Thus, each of the LDC regions is characterized by unique conditions that must be captured if long-range forecasting is to provide useful information to defense planners. The model to be described in increasing detail

in the next two chapters is constructed in a way that will allow for the idiosyncracies of each region to be represented explicitly.

Not until the interrelationships among important environmental characteristics, as they relate to change and growth in these three regions, are understood can effective alternative plans be proposed. Once future developments are understood, the policies taking such developments into account can be generated. In addition, forecasts can be linked to future demands for logistics, research and development, procurement, and actual combat situation requirements. Finally, it should be reiterated that the current modeling procedure has included a capability for planners, policy-makers, and forecasters to adjust certain variables that measure the impact of U.S. and Soviet policy on the developing countries in order to allow alternate policies to be introduced as forecasting over time proceeds. Thus, the LDC forecasting model ensures a dynamic absent from previous models.

CHAPTER 2: OVERVIEW OF THE LESS DEVELOPED REGION FORECASTING MODEL

INTRODUCTION

Chapter 1 alluded to the increase in complexity and sophistication demanded by any attempt to build forecasting models for the less developed nations. The purpose of this chapter is to elaborate some of the important issues that have necessitated the re-operationalization of the five central environmental descriptors (national power base, internal instability, international trade, international alignment, and international conflict) and the respecification of the equations by which the descriptors are forecast. The chapter covers four major areas.

- Differences between the European nations and those of three less developed regions.
- Re-operationalization of the five central environmental descriptors.
- Changes in predictor variables (both endogenous and exogenous to the model).
- Structural changes in the LDC model which make it different from earlier models.

Each study done by CACI for JCS/J-5 has attempted to maintain the conceptual equivalence of the central environmental descriptors because of their importance to strategic policy and planning. However, during the early stages of the current project it became apparent that differences between Europe and the less developed nations would require significant adjustments in the forecasting models for projecting significant political, economic, military, and social variables for the nations in Africa, Latin America, and the Middle East.

GENERAL DIFFERENCES BETWEEN EUROPE AND THE LESS DEVELOPED REGIONS

The European region is characterized by considerable similarity among the nations, that is, the structures that link important environmental variables differ little from one country to another. There is much more dissimilarity among the nations of any less developed region, especially in terms of the relationships among important environmental variables and with respect to the volatility, or variation, in LDC behavioral relationships.

For example, even though income levels, industrialization, and urbanization show variance within the European region, the basic structure of the modern European economies is similar (see McIlroy, 1974: 131-134). Thus, while the values for the European nations may differ, the variables interrelate in patterns that are similar enough to permit the construction of a generalized regional model that produces meaningful forecasts. In contrast, in the LDC's there are a number of important differences in the linkages among variables, as well as in the distribution of values, included in the present study which make a generalized model difficult to construct.

It is generally acknowledged that the Latin American nations have rather well established economic infrastructures compared to the traditional, agriculturally based economies of the African nations. Therefore, in Latin America, indigenous private investment contributes far more to the gross domestic product than in Africa. A general model would tend to obscure this fact by "splitting the difference" and diminishing the role of private investment in Latin America while over-emphasizing it in Africa.

The developing countries are invariably characterized by marked differences in other areas of economic behavior which would be obscured by more general models. For example, the Middle Eastern nations clearly depend at this time on their oil exports. Thus, the international economic sector contributes far more to the total economy of the region than in Africa or Latin America. Consequently total trade should play a larger role in the model for the Middle East than for the other regions.

A general model would also obscure the origins of defense spending and military manpower in the three regions. In Latin America the suppression of domestic unrest would appear to justify defense expenditures and large militaries whereas in the Middle East and Africa the propensity for international conflict would no doubt account for these variables.

Other factors that would be obscured, or misrepresented, by a general LDC model are population (the rates of population growth are significantly different in the three regions), urbanization, domestic conflict (the origins of coups and domestic turmoil differ from region to region), international conflict and international alignment (the influences of economic and political forces being more important in one region than another).

Another important difference between the European and the less developed regions concerns the role of the military in political affairs. Many nations in all of the less developed regions are dominated by military regimes that have gained power, more often than not, by coups d'etat. The implications of the military role in politics in the LDC's are far-reaching and extend into the economic and social sectors of the nation as well as into the area of foreign policy (Lieuwen, 1965; Janowitz, 1964).

Another distinguishing characteristic that must be considered in modeling the LDC regions involves the importance of the international economic sectors of the nations. This is to say, international trade and trade dependency are extremely influential determinants of both economic and political stability and growth (McIlroy, 1974; Jenkins, 1972; Horowitz, 1972; Galtung, 1971). At the same time, however, these conditions are often a source of anti-foreign behavior. The role of the international economic sector, as a source of income (from exports) and a cause of balance of trade problems (from imports), remains a highly sensitive issue among the LDC's and between the LDC's and the developed world.

The foregoing discussion alludes to two specific demands made on any effort to build forecasting models for less developed regions. The first involves

the operationalization of the five central environmental descriptors in ways that are sensitive to the characteristics idiosyncratic to the specific regions. The second involves the selection of appropriate independent variables for predicting the central descriptor variables and the specification of their interrelationships.

Re-operationalizing the Five Central Environmental Descriptors for the LDC Regions.

The first change made necessary by modeling the LDC regions involved the re-operationalization of four of the five central environmental descriptors. First, because of the complex process of economic change in the three Third World regions, the national power base concept was broken down into three components (see Figure 1) -- resource power, economic power, and military power. This is in contrast to the European conceptualization which considered only economic and military power bases (CACI, 1974). The measures used in the earlier model were designed to capture the technological bases of the European nations as they affect economic and military capabilities. In the LDC regions, technology per se plays a limited role in determining the relative power of nations. Therefore, to map effectively national power base, the economic component was decomposed into the specific variables that describe the complex of economic processes such as private consumption, investment, government spending (defense and non-defense), and exports and imports.

The second re-operationalization involved improving the domestic instability descriptor. A coup propensity indicator that attempts to measure a nation's history of irregular government changes has been developed. The variable, which focuses on the history of military takeovers, measures the propensity for violence that results from elite discontent with existing regimes in many developing countries. This kind of violence is generally absent in the European context but is both frequent and significant in the three less developed regions. In addition, the turmoil variable, also used in the European model, was redefined to represent better popular unrest in Third

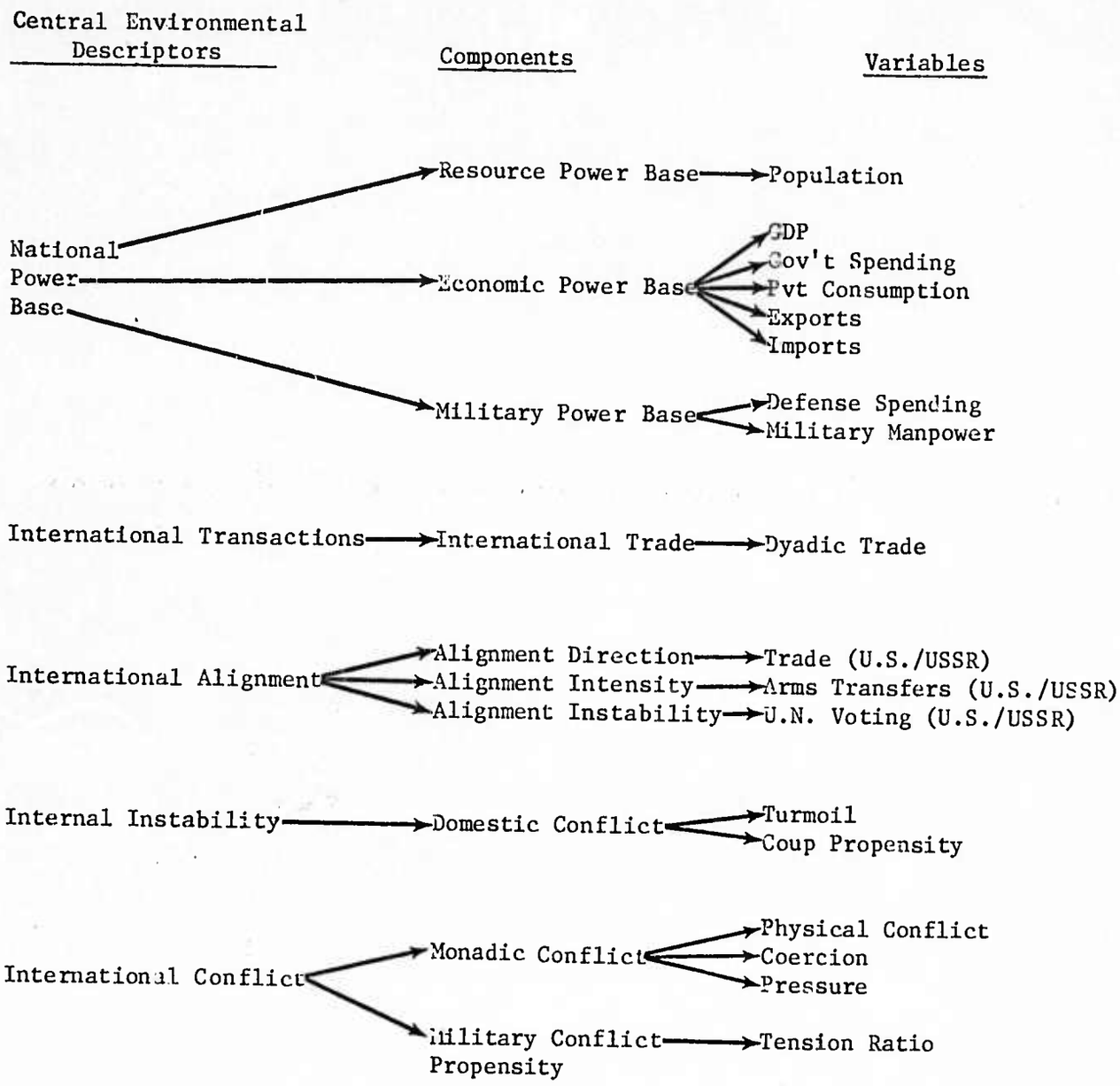

Figure 1. Central Environmental Descriptors, Components and Variables for the LDC Models.

World countries and to permit the use of more theoretically grounded relationships for forecasting domestic instability.

The third change dealt with the international alignment concept. This descriptor was enriched to take into account arms flows, international trade with the United States and the Soviet Union, and foreign aid. The extent and intensity of alignment on these variables and on U.N. voting with the superpowers (included in the European model) are used to capture the complexities of the international orientations of the less developed nations. In addition, these components are used to develop a measure of alignment instability which is based on the theory that the LDC's are (1) characterized by considerable instability in their international alignments and (2) attempts are made to resolve these instabilities over time by moving toward one pole or the other on all of the alignment indicators.

Finally, the international conflict descriptor had to be altered due to the scarcity of data for the three regions under examination. The dyadic conflict variable used in the European model was replaced by a Tension Ratio that takes into account the greater frequency of international military conflict in the LDC regions, particularly Africa and the Middle East.

Changes in Endogenous and Exogenous Predictor Variables

Altering the interpretation of the central environmental descriptors and introducing new operational referents to reflect the reconceptualized terms require that the variables selected to forecast the descriptors accurately represent the realities of the Third World. Thus, many new variables had to be added to the data base in order for reliable and empirically sound parameters to be estimated that would permit accurate forecasts to be generated by the overall forecasting model. Table 1 compares the LDC variables with those used for forecasting the European case.

TABLE 1

Europe	Less Developed Regions	
	Endogenous Variables	Exogenous Variables
Population	Population	Arms Trade with U.S.
Energy Consumption	Gross Domestic Product	Arms Trade with USSR
Gross National Product	Non-defense Government Spending	Military Aid from U.S.
Dyadic Trade	Total Imports	Military Aid from USSR
Alignment Distribution	Total Exports	U.S. Economic Aid
Alignment Intensity	Dyadic Trade	USSR Economic Aid
Turmoil	Defense Spending	Imports from U.S.
Revolt	Military Manpower	Exports to U.S.
Defense Expenditure	Alignment Intensity and Distribution (Trade)	Total Trade with U.S.
Military Manpower	Alignment Intensity and Distribution (U.N. Votes)	Total Trade with USSR
Monadic Conflict	Alignment Intensity and Distribution (Arms)	
Dyadic Conflict	Composite Alignment Intensity	
	Alignment Instability	
	Turmoil	
	Coup Propensity	
	External Conflict (by Nation)	
	Military Conflict Propensity	
	Government Type	
	Bloc Identification	
	Distance	
	Urbanization	
	Literacy	
	Employed in Non-Agriculture	

The variables that appear under the heading "Endogenous Predictors" exist within the overall model and enter into the forecasts of either other predictor variables or the central environmental descriptors being forecast. They are instrumental in calculating values of other instrumental variables or of the final forecasts.

The variables labeled "Exogenous Predictors" are not predicted by the model. They are included because they are theoretically appropriate and describe activities that reflect political decisions. Thus, the amount of military aid can be adjusted to reflect improved relations between two nations. The interaction of the military aid variable, in turn, can have an effect on other variables such as defense spending, GDP, and international trade. In this way, shifts in policy can be assessed for their impact on the entire system of equations and the outputted forecasts.

The exogenous predictor variables are specifically representative of the impact of the United States and the Soviet Union on the forecasts in the three regions. Thus, the JCS/J-5 analyst is provided a capability within the forecasting model to manipulate the final outcomes of the modeling process by causing changes in the exogenous predictor variables.

Changes in the LDC Model Structure

The LDC forecasting model has expanded the number of forecasting equations from 12 to 21 in an effort to capture the many nuances that characterize the nations of Africa, Latin America, and the Middle East.[1] Although the 21 equations are generally applicable to representative LDC's, the set of equations is being tested and estimated for each region. This means that parameters estimated for forecasting the configurations of political, economic, military, and social variables will be generated for each region. It is almost certain that some predictors will appear insignificant for one region and significant in another. In such a way, the structural differences of each region can be captured by the overall, general model structure.

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[1] See Appendix 2 for the complete model structure.

In addition to the above changes, the models to be tested, estimated, and forecast reflect, in accordance with the suggestions of JCS/J-5, three additional concerns:

- The majority of the variables are measured so as to reflect change in a nation's value on the forecast variables.
- The equations include variables that capture the influence of the United States and Soviet Union on the behavior of the LDC's in each region.
- The model, although a general model for LDC's, is built such that unique forecasting models can be constructed for each of the three regions.

The first improvement involves the use of measures of change in variables measuring LDC phenomena. This is to say that the real substantive concern of the current study is the change that is reflected from one time to another in the variables being forecast and not simply the forecast values themselves and their distributions. This new perspective is important because it allows comparisons of rates of change to be evaluated for their implications for strategic policy and planning. Thus, comparisons between regions can be made with regard to economic growth, changes in military expenditure, movement toward or away from domestic instability, shifts in alignment patterns, and so on.

It is a rather well-established fact that the African nations have progressed economically at a rate below that of the Latin American countries. However, this situation may not occur in the future. The Middle Eastern nations, on the other hand, are now capable of fairly rapid growth but they remain nearly as underdeveloped as many of the African nations. By looking at rates of change rather than static measures of social, political, and economic phenomena, a dynamic is introduced that is absent from earlier forecasting models.

The second structural change that has been introduced involves the inclusion of specific exogenous variables that operationally permit the impact

of the United States and the Soviet Union on the LDC's to be judged. Some of the variables included measure U.S. and Soviet trade with the LDC's in each region. Others measure arms transfers, military and foreign aid, and cooperative behaviors. Each of these variables is exogenous to the basic LDC forecasting model. Therefore, each can be manipulated in two ways. For example, the degree or amount of U.S. activity (arms transfers, aid) can be altered before forecasting begins to determine the impact of increases or decreases in the activity on the forecasts of the future LDC environments; or the coefficient reflecting the impact of the exogenous predictor variable can be changed to give the variable greater explanatory power causing proportional changes in the dependent variable being forecast. Again, it is readily apparent that this inclusion introduces far greater flexibility and allows alternative future environments to be generated.

The inclusion of exogenous variables permits comparison of different policies of the United States and the Soviet Union. Does an increase in Russian trade with a group of African nations have a greater impact on other dimensions of international alignment than it would in Latin America? What is the impact of increased or decreased exports as a result of an embargo (simulated) on growth in the Middle East? These and many other similar questions can be asked and answered as a result of the introduction of the exogenous variables that are manipulable by the analyst.

The third alteration is actually one of technique rather than substance. The LDC model to be programmed for forecasting is presented in its entirety in Appendix 2. Each equation in the model will be tested individually for <u>each region</u>. There are good reasons for this procedure. For example, although several variables are included in an equation for either theoretical or empirical reasons, the impact of each remains in some cases an empirical question to be answered by the testing process. Since the tests will apply to each of the three regions, coefficients that are <u>region-specific</u> will be generated. It is not at all unreasonable for a parameter to be zero in one region (have no impact) and significantly greater than zero in another

(have a measurable influence in the model). Hence, the same equation may be used in all three regions, but the different equation parameters result in very different models and in very different sets of important variables in each of the three regions. As an example of what is meant here, consider the equation for change in defense expenditure:

$$\Delta DEFEX_{t,t-1} = \beta_{9,0} + \beta_{9,1}\, \Delta DEFEXA_{t-1,t-2} + \beta_{9,2}\, USARMS_{t-1} + \beta_{9,3}\, SUARMS_{t-1} \quad (9)$$

$$+ \alpha_{9,4}\, \Delta \frac{GDP}{POP}_{t-1,t-2} + \alpha_{9,5}\, CONFLICT_{t-1} + \beta_{9,6}\, \frac{\sum_{i=1}^{5} MILAID_{t-5}}{5}$$

where DEFEXA represents the defense spending of actual or potential adversary nations and MILAID consists of two variables, U.S. and Soviet military aid.

This equation, as it is written, says the following. A change in an LDC's defense spending from one year to the next is a function of several factors. First, it is hypothesized that the relative military capability of rival nations influences the amount that a nation spends on its own defense. The term DEFEXA refers to rival defense spending and is a rough indicator that attempts to capture the phenomenon of arms races. The second and third terms reflect the impact of arms sales from the United States and the Soviet Union to the country. Clearly, the amount a nation spends on defense will reflect its purchase of arms. Here, however, only the two most important arms suppliers in the world are represented. The next term reflects the impact of the size of the nation's per capita income on defense spending. It is generally held that defense spending is in part a function of the general wealth of a nation--there is a positive correlation between per capita income and defense spending (Richardson, 1960a). When nations are in conflict they also spend money on weapons and defense; this is the rationale behind the inclusion of the variable that measures a nation's past engagement in conflict. Finally, because arms transfers reflect the sale or purchase of arms and not military assistance received, a variable that measures the amount of military aid from the United States and the Soviet Union over the past five years is included in the equation. Again, the influence of the two superpowers

should have an impact on the extent to which government spending supports defense. And, it should also be noted that both of the variables, arms transfers and military aid from the United States and the Soviet Union, are manipulable exogenous variables as described previously.

In the African case, because of numerous conflicts in the early and middle 1960's, DEFEX would probably be explained more by rival defense spending ($\Delta DEFEXA_{t-1,t-2}$, past conflict ($CONFLICT_{t-1}$) and change in GDP per capita. The impact of these three variables would then be reflected in the size of the parameters resulting from testing the equation for the African region. In contrast, because of the absence of intra-regional military violence in Latin America, past conflict will be an insignificant predictor of change in defense spending in that region. But, in contrast, military aid and arms transfers might contribute substantially in Latin America where they do not in Africa.

On the basis of these findings the parameters for the insignificant variables can be set to zero so that they will contribute nothing to the forecast of the dependent variable. This means that the DEFEX equation for Africa will look like:

$$\Delta DEFEX_{t,t-1} = \beta_{2,0} + \beta_{2,1}\,\Delta DEFEXA_{t-1,t-2} + \alpha_{2,4}\,\frac{\Delta GDP}{POP}_{t-1,t-2} + \alpha_{2,5}\,CONFLICT_{t-1}$$

and for Latin America will take the form of the original equation with only the past conflict variable ($CONFLICT_{t-1}$) deleted.

Some of the more obvious areas where this technique becomes an appropriate discriminatory device for developing unique regional models are the following. The model should reveal the extent to which Africa, Latin America, and the Middle East differ regarding the most influential components of the economic sector. No doubt, in the Middle East, the domestic economic variables will contribute less to a nation's GDP than those capturing the influence of international trade. In Latin America, the economic base should be reflected by the contribution of all of the economic variables because of the greater

amount of integration in those economies. The traditional nature of the African economies and their dependence on trade should be revealed by the model as well. Thus, it is expected that the appropriate variables will appear as powerful explanatory variables in some regions but not in others.

Aid and arms transfers should appear as influences on defense spending in the Middle East and Latin America. Past conflicts should also contribute to the increase in defense spending in the Middle East and Africa but not in Latin America. In each area, therefore, the sources of military strength should appear unique. In addition, change in military manpower should derive from different influences -- international conflict in Africa and the Middle East and domestic violence in each region.

International alignment should reflect the influence of the United States in Latin America and that of the Soviet Union in the Middle East. Neither superpower should be overly represented in Africa but the growing influence of the Soviet Union should be captured by measures of foreign and military aid.

Finally, domestic instability should reveal its different origins from one region to another. In those regions experiencing rather rapid growth and disequilibrium, turmoil should have economic origins. In Africa, political motivations seem to account for most anti-government activity. In all regions the history of irregular government changes suggests that domestic instability would be a function of past instability.

This chapter has provided a brief overview of the LDC forecasting model and the changes that have been necessary in order to build a system of equations that accurately reflects the many nuances that characterize the less-developed regions. In building such a model, the differences between the developing and developed nations were taken into account and led to significant differences in interpretation and conceptualization of the five central environmental descriptors when applied to the less developed regions. Finally, the alterations to the overall model structure were described and three

specific inclusions elaborated. They were (1) emphasis in the model on rates of change over time, (2) focus on the influence of the United States and Soviet Union on the less developed regions, and (3) the generation of three unique regional models from a general LDC forecasting model.

This last improvement allows three separate models to be easily developed out of a single computer model while realistically capturing the regional differences of importance to long-range forecasting of strategic policy and planning. Again, it should be emphasized that this approach adds considerable dynamism to JCS/J-5's long-range forecasting capability and paves the way for additional innovations that should advance that capability even further.

CHAPTER 3: FORECASTING EQUATIONS FOR AFRICA, LATIN AMERICA, AND THE MIDDLE EAST

INTRODUCTION

This chapter describes the forecasting equations for the three less developed regions--Africa, Latin America, and the Middle East. The purpose of the discussion is to elaborate the specific models developed to forecast the variables that operationalize the five central environmental descriptors--national power base, international trade, international alignment, internal instability, and international conflict. Each model reflects contemporary theoretical and empirical relationships that represent the predictors of each dependent variable as realistically as possible. As indicated in the preceding chapter, the LDC forecasting model draws on, but is significantly different from, the European model. Thus, each operationalization of an environmental descriptor is necessarily more complex and requires additional, elaborate support for the proposed interrelationships specified in each equation.

The discussion to follow will deal with each of the 21 LDC equations independently. These are grouped under the five central descriptors of interest. Table 1 shows the page at which each discussion begins.

The addition of more operational referents[1] and equations is by no means designed to enhance complexity for complexity's sake. Rather, complexity occurs because of the nature of the study--the construction of forecasting models for three highly diverse, less developed regions of the world for comprehending future strategic policies, plans, and requirements.

[1] See Table 1 in Chapter 2 for a comparison of the European and LDC variables.

TABLE 1

Structure of Chapter III

Because many of the interrelationships among the variables identified as relevant for describing LDC's are in fact less well understood than those describing the developed nations, many of the equations to be presented below must be considered tentative. Indeed, each of the equations represents a hypothetical statement which describes the contribution of each independent variable of a forecasting equation to the explanation of variation in the dependent variable being forecast. Although each equation is written as if the independent variables make a positive contribution to the explanation of variance in the dependent variable, this is not assumed to be the case empirically. The analysis of each model shall reveal the direction of the relationship between the proposed independent and the dependent variables and shall allow the specification of the direction of the contribution of each variable to the dependent variable in the final forecasting model. This is a standard forecasting technique that allows theoretical and empirical flexibility. Complexity, therefore, is necessary if the forecasting equations are to capture the intricacies of the three regions that impinge on the political, economic, social, and military interests of the United States.

Once the equations have been evaluated for their explanatory power and the entire LDC model determined to be representative of the LDC regional environments, its value as a structure for projecting the future of each environment will have been established. It can then be employed for its stated purpose: the projection of three separate regional environments into the future.

However, it must be emphasized that forecasts are not useful in and of themselves. The purpose of such forecasts is to assess future strategic requirements demanded by alternative futures. These requirements can take many forms including strategic policy and objectives, contingency and ad hoc planning, procurement and research and development, deployment and targeting, and training and manpower acquisition.

Each forecast descriptor suggests future needs of the Department of Defense for dealing with the projected environment that the descriptor, and its

forecast, represent. Yet descriptors cannot be viewed in isolation. The entire picture must be comprehended for the LDC regional forecasts to be useful and meaningful. Only in this way can each equation, the entire LDC model, and the forecasting procedure in general, be helpful in determining long-range strategic requirements for formulating future policies, objectives, plans, and capabilities.

NATIONAL POWER BASE

Power, as a cause and/or an effect, invariably finds its way into research in international relations. The bulk of the empirical studies on national power and its relationship to international behavior have focused on the developed nations because of the crucial roles they have played in the post-World War II period. Power, however, plays a role in the behavior of all nations, both developed and underdeveloped.

Numerous studies[2] employing quantitative methods have "discovered" the empirical bases for national power. Usually national power base is discussed in military terms. The economic aspect of national power is usually discussed in terms of development. The contribution of resources to national power has generally been assumed to have found its way into each of the other dimensions.

Military and economic power are often treated separately for analytic purposes. However, this is a distortion of the real and important linkages between them. Many of the studies from which these findings are derived examined only the developed world. In the less developed world military and economic power are closely linked and the ability to discriminate between them diminishes greatly when the countries of Africa, Asia, Latin America, and the Middle East are analyzed separately.

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[2] Among the numerous international relations studies that have analyzed the indicators of the bases of potential power are Heiss, et al. (1973), Ferris (1973), CACI (1973, 1974), Knorr (1970), Organski (1958), Organski and Organski (1961), Abolfathi (1975a), Cole (1965), Rummel (1972), Morgenthau (1973), German (1960), and McIlroy (1971).

McIlroy (1971) in a study that disaggregated all nations into four regions (Europe, Asia, Africa, and Latin America) factor analyzed cross-sectional data (only the year 1955 was used) that included indicators of military, resource, and economic power to determine if dimensions similar to those that appear in global analyses would emerge. In general, two clusters of interrelated variables, one consisting of the standard measures of military and resource power (defense spending, population, national income) and the other consisting of the standard measures of economic development (GNP per capita, literacy, employment distribution) emerged.

This is a similar factor structure to that found when analyses of developed states and the global system are performed. But, in analyses of a set of highly developed countries, however, these dimensions are very distinct--they do not overlap. The pattern in McIlroy's less-developed regional analysis was different. The relationships were weaker and variables shifted from one factor to another depending on the region. For example, the indicators of military power and economic power form almost a single dimension in Africa but are less mixed in Latin America. To determine the similarity between the two clusters of variables for each region a factor comparison was done (for example, military power base in the Asian region was compared with military power base in the Latin American region). This subsequent analysis revealed that cross-regionally the dimensions differed substantially.

These findings, although tentative, suggest that while the same variables may be used as indicators of military, resource, and economic power in developed and less developed regions, (1) the distinction between the three kinds of power is less explicit in the LDC regions, (2) the components of each kind of power differ substantively from one region to another, and (3) attempts to operationalize national power in the LDC context must consider the complex interrelationships among the military, resource, and economic factors if power is to be adequately measured.

Another study on the power capabilities of nation states that is relevant to selecting indicators for the current study reveals more precisely the interrelationships among several indicators of power. Ferris (1973) studied nine variables as measures of power. These included:

- Area
- Population
- Government revenues
- Defense expenditure
- Total trade
- Armed forces
- Government revenue per capita
- Defense expenditure per capita
- Trade value per capita

Ferris' study covered the 1850-1965 period and revealed that the over-time relationship among most of the nine variables was generally stable. His analysis, which used all nations for the period, suggests that on a global level power can be measured by some or all of the nine variables and that they interrelate consistently with one another. This finding is further support for considering an operationalization of power that tries to capture its many nuances.

Another significant finding of Ferris' study was that defense expenditure, population, government revenue, trade, armed forces, and area consistently showed strong association with each other (that is, with a single cluster of interrelated variables named power). Moreover, Ferris found that his per capita measures of government revenue and defense expenditure increased their association over time. This finding suggests a positive feedback system in nations in which wealth and power constantly reinforce each other. This finding has been considered in the construction of the LDC model. Defense spending has been separated out from total government

spending as a component of the total economy. At the same time, the total economy (GDP per capita) contributes to defense spending so that as one variable grows, the other will do likewise. Thus, the positive feedback loop is operationalized and the reinforcing nature of all aspects of national power base are incorporated into the model.

The present study therefore utilizes the trends in several power indicators to forecast their future levels. The overall direction of the study, however, is not merely to analyze trends but to examine "causal" relationships between indicators, forecast future environments based on these relationships, and draw conclusions about future strategic needs and requirements.

The indicators of power selected for this study were based on the work of previous researchers wherever possible. However, they represent a more structured set of indicators and, unlike many previous studies, were not arbitrarily aggregated into a single index. Such aggregation achieves little beyond loss of information. Students and practitioners of power emphasize that power is a multidimensional phenomenon and that operationalizations of power should attempt to capture the many features of the concept. Therefore, power will be treated as consisting of three components--resource power, economic power, and military power.

The basic components of power for the current LDC study are similar to those identified for the European analysis. However, the models developed to predict the operational referents used to measure each component are considerably more complex.

(1) Resource Power Base

- Population

(2) Economic Power Base

- GDP (or GNP)
- Trade
- Government expenditure

(3) Military Power Base

- Defense expenditure
- Military manpower

Resource Power: Population

In the LDC context, the possession of natural resources has only recently become a source of power. Here, of course, we are referring to the considerable enhancement of power (primarily economic power) of the LDC members of the oil-exporting community. The success of this small group of countries notwithstanding, the majority of LDC's are incapable of converting their natural resources into the hardware of power because they still lack the necessary economic and political infrastructure. Their primary natural resource, and one whose contribution to a typical LDC's power base is somewhat dubious, is people. Population can be advantageous to a nation simply in terms of numbers. However, it can be a detriment as well when food, clothing, and other basic needs become a problem. Nevertheless, population is clearly a potential source of power when general economic and military forms of power are limited.

As in last year's effort, population is an important forecast variable in this study of Latin America, Africa, and the Middle East. Regardless of the level of economic development, some minimum population is required if a nation is to exploit effectively its natural resources and to employ high-energy production techniques (Aron, 1966: 229). A large population also provides the necessary domestic market for local industry (Organski, 1958: 141). In short, no nation can become or remain a significant world or regional power without the population necessary to establish and maintain an industrial base, to field combat units, and to feed and equip the soldiers and citizenry (Morgenthau, 1973: 119).[3]

[3] See also Organski and Organski (1961), Cole (1965), Ferris (1973), Knorr (1970), Heiss, et al. (1973), and German (1960) for relationships between population and national power.

Moreover, forecasts of population provide a means of meaningfully comparing forecasts of other variables for nations of greatly differing sizes. Forecasts of gross domestic product (GDP), for example, cannot be used to infer relative levels of economic development for countries very different in population size. Per capita forecasts, which require an estimate of future population size, reduce much of this comparability problem.

In the European study, population size was forecast by applying past growth rates to previous population size, resulting in an exponential growth curve, and attenuating this curve by including GNP per capita as a predictor of population. There are, undoubtedly, a complex set of factors that account for the inverse relationship between population growth rates and level of wealth, a complexity that is not captured entirely by per capita GNP differences (Demeny, 1974). While such a gross indicator seems satisfactory for differentiating very wealthy from very poor nations in terms of population growth rates, it is probably unsatisfactory for differentiating among less developed nations. Rather than attempt to include the complex of social, economic, political, and technology factors that influence population growth, population in LDC's can best be forecast by applying estimates of future population growth to past population levels based on the assumption of constant population growth.

The growth rate for the population model is drawn from the work of U.N. demographers rather than estimated from the data base assembled especially for this study. This approach will insure the necessary variability in the population model for LDC's and, in this context, will yield more useful and realistic forecasts than would the application of the techniques used for forecasting population in the European region.

The assumption of constant population growth must be qualified. Almost all population experts agree that the present rates of population growth in the less developed countries are too high to last for very long (Freedman and Berelson, 1974) and that sooner or later growth will level off due to either high death rates or low birth rates (Coale, 1974 and Revelle, 1974). Yet it is difficult to predict when the leveling off will occur.

The prediction of a decrease in population growth is based on knowledge of the development, urbanization, and industrialization processes. As a general rule, as societies develop and industrialize, populations move from rural areas to urban centers, extended families are broken up into nuclear families and ultimately population growth approaches zero (Pressat, 1970). This has been the experience of the industrialized nations. The exact nature of this process, however, is only vaguely known.[4] Moreover, its pace seems to be partially controlled by a host of other factors and rates of change vary widely from society to society. At this stage of knowledge, it is impossible to say at what level of development a country will approach its zero population growth (Demeny, 1974). The approach taken in this project is to utilize a constant rate of population growth for each country except in cases where population growth rates actually decline. In such situations different growth rates can be used for different periods. Thus, the population model takes the form:

$$POP_t = (1+c)POP_{t-1} \qquad (1)$$

where c (population growth rates) are taken from extant literature for each country.

National Economic Power Base

Few aspects of a society have as obvious and as far-reaching an impact as its economy. It is the level of economic wealth and rate of economic growth that, in the final analysis, determine a nation's capability or

[4] Demeny (1974) claims that there is no statistical relationship between birth rates and GNP per capita among "underdeveloped countries with more than 10 million population." However, by limiting his sample to underdeveloped countries and excluding countries with less than 10 million population, he substantially reduces the variance in his data. Moreover, in a scattergram of birth rates versus GNP per capita (p.155) there is a distinct relationship which is somewhat weakened by unusual countries. For instance, oil-exporting countries such as Venezuela, Iran, and Iraq, which have exhibited very fast growth rates, tend to have had a slower decline in their birth rates than one would have expected based on the statistical trend of cross-sectional data. On the other hand, China and Sri Lanka, which have had rigorous birth control programs, have had faster declines in their birth rates than the expected trend would have suggested. For example, of different population growth forecasts, see Department of State (1974) and Cooper and Alexander (1971).

potential for undertaking domestic and foreign policies. Indicators of national behavior (in such diverse areas as budget expenditures, diplomatic activities, and trade) tend to be correlated with total national income of countries.[5] Moreover, countries undergoing a rapid increase in their per capita income tend to be relatively immune to military coups even though they may experience other types of turmoil. Indeed, it is significant that countries with rapid rates of economic growth can sustain a greater level of wealth and income inequality by raising the overall median income level for the nation. At the same time, such nations are able to expand rapidly their international activities.[6]

This point is of particular relevance to the oil-exporting countries of the Middle East, Africa, and Latin America. The rapid rise in the oil revenues of these nations has radically increased their potential capabilities for engaging in both domestic and international activities. The classical "guns versus butter" dilemma, for instance, is no longer a problem in Saudi Arabia. The Saudi government has been increasing not only its military and social welfare expenditures by unprecedented rates but it has also inaugurated substantial foreign aid programs and invested large amounts in advanced industrial countries.[7]

The importance of the economic sector to nation-states requires that considerable attention be paid to constructing a model for long-range forecasting. The model presented below consists of the general equations to be used for forecasting. It should be emphasized that the equations are presented in their most general forms and it is possible that for some

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[5] See Dabelko and McCormick (1975), Abolfathi and Park (1975), Morley (1971), Mitchell (1927), Maddison (1969), and Peters (1972).

[6] With the exception of post-war military activities, Japan is an excellent example of how economic growth leads to increases in other areas of national activity.

[7] Another example of the impact of increased economic wealth on nations is Iran. In the last several years Iran has doubled its diplomatic representation abroad and has increased its defense expenditure by at least five times. See also Iskandar (1974), Abolfathi (1975c), and Beedham (1975).

cases the final version used for forecasting will have a slightly different form. To simplify the notation and clarify the exposition, the equations are discussed as if they referred to a single country. With one exception (to be noted) each of the following equations applies to all countries.

There are two basic economic variables for each country in the overall model--gross domestic product and foreign trade. In order to estimate those variables successfully, to forecast their future paths, and to assess policy changes, it is necessary to construct a set of equations that describes economic patterns within each country.

Nine major variables will be utilized to represent the economic sector of each country:[8]

GDP = gross domestic product

POP = population

DEFEX = defense spending

DOMEST = non-defense government spending

INVEST = investment spending

CONSUMP = consumption spending

TIMPORT = total imports

TEXPORT = total exports

EXPUS = exports to the United States

IMPUS = imports from the United States

To identify the values of these variables in different time periods, subscripts are employed. To illustrate, INVEST indicates investment spending in period t, and $INVEST_{t-1}$ is investment spending in the previous

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[8] EXPUS and IMPUS also will be used to determine a nation's international trade alignment.

period. In a similar manner, $INVEST_{t-2}$ refers to investment spending two periods prior to period t. The time periods for the model are one-year intervals.

The "economic model" for each country is developed from Keynesian income-expenditure analysis. By definition, income equals production in each period. Further, spending, appropriately defined, also equals production. The task is to identify the components of spending and develop equations describing each of the components. The sum of the components is total production, gross domestic product, or GDP.

The initial classification of spending depends upon the economic sectors of a country and their position with respect to the economy in question. Three basic types of spending are identified: (1) private spending (2) government spending, and (3) foreign sector spending. Each of these types is then divided into components to describe the motives (or variables) influencing them more accurately and to represent these motives as equations.

Private Spending

Private sector spending in an economy is divided into two components, consumption and investment spending. Consumption (CONSUMP) is the spending by persons in the economy. Investment (INVEST) includes the money spent to finance plants and equipment (capital goods) and to finance inventory accumulation (or inventory runoffs).

Private consumption, $CONSUMP_t$, is described as

$$CONSUMP_t = \beta_{2,0} + \alpha_{2,1} GDP_t + \alpha_{2,2} CONSUMP_{t-1} \qquad (2)$$

The basic influence on consumer spending is consumer income. GNP is included as a proxy variable for the "true" measure of consumer income (for example, disposable income). The justification for the use of GDP

as a proxy variable derives from the application of the model to less developed countries for which data on disposable income are generally unavailable.[9] Previous year consumption is included as a way of capturing an adjustment effect. Large changes, decreases or increases, in income are often not translated immediately into proportional changes in consumer spending. Some adjustment time is required to determine the pattern of spending reflected by changed income.

Investment spending is included in the model on the assumption that businesses construct plants and purchase equipment as they expect to be able to sell the products to be manufactured in these facilities. The problem is that the model must forecast investment spending before the value of total sales in the economy is known. The assumption employed to resolve this difficulty is quite simple and defensible--the pattern of expected future sales is determined by past patterns. Hence, investment spending is:

$$INVEST_t = \beta_{3,0} + \alpha_{3,1} \Delta GDP_{t,t-1} \qquad (3)$$

Government Spending

Two types of government spending are identified within the model, defense (DEFEX) and non-defense (DOMEST). Defense spending is influenced by "political" factors and is discussed in the section "Defense Expenditure" in this report. It is an "exogenous" variable from the perspective of the economic system being discussed here. The current period level of defense spending is not determined by current period economic influences, but it does influence current economic conditions.

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9. For any country that reports disposable income (or perhaps personal income), the equations are easily modified to:

$$CONSUMP_t = \beta_{2,0} + \beta_{2,1} Y_D + \beta_{2,2} CONSUMP_{t-1}$$

where Y_D is disposable income. An equation $Y_{Dt} = \beta GDP_t$ is then added to the model. This is a minor extension, and can be applied wherever sufficient data are available.

Non-defense government spending, $DOMEST_t$, is described by:

$$DOMEST_t = \beta_{4,0} + \alpha_{4,1} DOMEST_{t-1} + \alpha_{4,2} GDP_{t-1} + \alpha_{4,3} POP_t \quad (4)$$

To evaluate this equation, first note that last period's non-defense spending is included to capture the inertia that typically characterizes government economic policy and behavior. Effectively, the tendency is to maintain government spending despite influences to change spending from previous levels.

The inclusion of lagged GDP as an independent variable is designed to capture the influence of the level of total economic wealth of the nation on government activity. It is generally true that greater income for the country as a whole implies a more than proportional increase in government spending. This reasoning suggests that the expectation is for $\beta_{4,1}$ to be positive and greater than one.

The influence of population is not easily predicted. On the one hand, a larger population will tend to increase government support of public services such as education. On the other hand, if population growth exceeds GDP growth, the per capita welfare of the country is reduced and can be expected to depress government spending. Despite these offsetting explanations, there is no reason to suppose the effects are perfectly offsetting for each country (for example, $\alpha_{4,3} = 0$ is an unlikely result).[10] Empirical parameter estimation will be used to identify the proper values for use in the model.

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[10] It should be noted that this treatment of government expenditure is quite unlike those found in the conventional treatments of public expenditure economics which view government expenditure from the vantage of decision-makers and optimization theory. Such treatments are of limited value for long-range forecasting unless one could make better forecasts of decision-makers' preferences and the constraints under which they operate. See Millward (1971).

Foreign Sector Spending

The remaining areas of spending to be considered are components of the foreign sector, export sales (spending from other countries) and imports (spending going to other countries). The algebraic descriptions of these two aspects of spending are quite similar but the equations are interpreted differently. Imports are described by:

$$TIMPORT_t = \beta_{5,0} + \alpha_{5,1} GDP_t + \alpha_{5,2} POP_t \qquad (5)$$

In many respects the import equation is interpreted in a manner analogous to the consumption equation. First, GDP influences consumer spending as a measure of income and operates similarly in the import equation. Second, GDP reflects the country's endowments of resources, and when controlled for population, approximates technology (or per capita wealth) to determine imports.

The size of the country's exports is estimated by:

$$TEXPORT_t = \beta_{6,0} + \alpha_{6,1} GDP_t + \alpha_{6,2} POP_t \qquad (6)$$

The justification for this equation is identical to that for the import equation. Both equations are included in the economic system because most countries do not exhibit a perfect balance on their merchandise trade accounts. In particular, less developed countries often run deficits, indicating that the response of exports differs from that of imports as GDP and POP change over time. Moreover, their exports tend to exhibit greater instability due to extreme fluctuations in demand for raw material exports.

The Total Economy

The gross domestic product of the country is the simple sum of all types of spending.

$$GDP_t = CONSUMP_t + INVEST_t + DOMEST_t + DEFEX_t + TEXPORT_t - TIMPORT_t \quad (7)$$

where TEXPORT and TIMPORT include exports to the United States and imports from the United States as separate variables.[11]

Imports are subtracted because that component of spending goes out of the country. Put another way, the terms CONSUMP, INVEST, DOMEST, and DEFEX all represent the total spending for each type of activity. But some part of each type is used to purchase imported products and as such never reaches the producers within the economy. Hence, this element of spending will not call forth production and must be subtracted.

U.S. Impact on LDC Economies

The list of economic variables presented above includes, for each country, exports to and imports from the United States. These were specified to be able to consider within the model the effects of changing U.S. trade policies on other countries.

To build the influence of trade with the United States into the LDC model, nothing must be added to the economic system for each country. However, a forecasting equation for the U.S. component of trade must be introduced. This amendment to the LDC model demands only that the U.S. trade sector be modelled. A full model of the U.S. economy is not required to capture interactive effects. Therefore, only two equations need to be introduced:

$$GNPUS_t = (1+c)GNPUS \text{ and}$$
$$\log IMPUS_t = \beta_0' + \beta_1' \log GNPUS \quad (8)$$

The first of these equations establishes a linear extrapolation of U.S. GDP into the future.[12] The second equation establishes the magnitude of

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[11] These two variables, therefore, represent manipulable exogenous components of the GDP equation that can be utilized to reflect shifts in U.S. trade policy toward a given country.

[12] If during the estimation stage another functional form is found to produce better prediction, there is no difficulty created by changing the specification.

U.S. imports. The geographic distribution of U.S. imports can be obtained from historical data to provide the basic trade patterns for the model. The inclusion of these two equations permits the distribution of trade to be manipulated as if policy has been altered. For example, an embargo could be simulated by arbitrarily redistributing trade so that trade to one region reduces to zero and increases proportionately to other regions. The implications of this action then would allow the impact of the embargo on LDC economies to be evaluated. Using this approach, it will be possible to examine the long-term effects of increases or decreases in U.S. imports on particular LDC's, on groups of LDC's, or on entire geographic regions. Thus, the direct influence of U.S. actions on each country can be evaluated as can the spread of the impact to other countries as trade over time is affected.

Military Power Base

Military power is measured by the value of governmental military expenditure and level of armed forces. As measures of military power these variables are open to several criticisms. Particularly, it can be argued that (1) they are not exhaustive, (2) they put too much emphasis on quantity (versus quality), and (3) they ignore the efficiency and intensity of utilization with which they could be used.[13]

It should be noted, however, that defense expenditure does not necessarily represent only the quantitative aspects of military power. Each dollar of

[13] The typical example illustrating the inadequacy of these measures is the Arab-Israeli military balance prior to the 1967 war. In that war the quantitative balance was close. However, the qualitative balance was overwhelmingly in favor of the Israelis. Israel had by far the superior command and control capability. Arab armies generally had very poor field intelligence and little coordination during the war. The Israeli tactics were more suited for a constantly changing combat environment. The Israeli logistic support was also far more efficient. In the 1967 war the Israeli qualitative superiority proved decisive. In less than six days Arab armies were completely defeated, most of their major weapons were either captured or destroyed, and 15,000 Arab soldiers were either dead or captured. The greatly enhanced capacity of some of the Arab military forces in 1973 serves as a reminder that relatively rapid changes can occur in these variables, particularly when enough resources are available.

defense expenditure can be spent on qualitative as well as quantitative improvements of military capability. This is not to deny that existing levels of skill, technology, and organizational-administrative capabilities do act as a constraint. What is emphasized here is that in the long run the major constraints appear to be the more basic economic and resource variables. Therefore, the use of military expenditure tends to be highly correlated with other indicators of military power for major powers, medium powers, and small powers (Abolfathi, 1975b). Furthermore, by dividing total military expenditure by number of personnel in the armed forces it is possible to arrive at an indicator of the quality that would be adequate for long-range forecasting.[14] It should be noted, however, that such an indicator would be too rough for short-term forecasting, which requires far more sensitive indicators.

The Equations of Military Power

The basic equations that will be used for forecasting the long-range military power of nations states are shown below.[15] Variable definitions and sources can be found in Appendix 3.

$$\Delta DEFEX_{t,t-1} = \beta_{9,0} + \beta_{9,1}\ \Delta DEFEXA_{t-1,t-2} + \beta_{9,2}\ USARMS_{t-1} + \beta_{9,3}\ SUARMS_{t-1} \quad (9)$$

$$+\alpha_{9,4}\ \Delta \frac{GDP}{POP}_{t-1,t-2} + \alpha_{9,5}\ CONFLICT_{t-1} + \beta_{9,6}\left(\frac{\sum_{i=1}^{5} MILAID_{t-i}}{5}\right)$$

where DEFEXA represents the defense spending of actual or potential adversary nations and MILAID consists of two variables, U.S. and Soviet military aid.

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[14] It has been assumed that the impact of defense expenditure on the economy is a simple additive independent variable in the equation for GDP. In reality, the economic impact of defense expenditure is probably more complex. But this relationship is yet to be defined and tested by economists. Attempts have been made by Benoit (1973), Ishi (1974), Szymanski (1973) and Zeitlin (1974) but the results of these studies have not been consistent.

[15] All equations in this report are preliminary and can be finalized only after complete parameter estimation and final structure decisions.

$$MILMAN_t = \beta_{10,0} + \alpha_{10,1} MILMAN_{t-1} + \alpha_{10,2} CONFLICT_{t-1} + \alpha_{10,3} TURMOIL_{t-1}$$
$$+ \alpha_{10,4} \Delta \frac{GDP}{POP}_{t-1,t-2} + \beta_{10,5}\left(\frac{\sum_{i=1}^{5} MILAID_{t-5}}{5}\right) \quad (10)$$

The defense spending equation, in essence, describes the relationship between annual changes in the level of military expenditure on the one hand and superpower arms transfers, annual changes in GDP per capita, arms races, and conflict on the other. In other words, an increase (or decrease) in defense expenditures is assumed to result from an increase (or decrease) in wealth, involvement in arms races, conflict and arms transfers,[16] or all of these together.

The relationship between conflict and defense expenditure at first seems obvious. There are numerous anecdotal references to conflict events that have led to increased rates of defense expenditure, conscription, mobilization, arms races, and war. The relationship between conflict and military expenditure was first mathematically formalized by Richardson (1960b) and has found statistical support in the works of Newcombe (1975). But Richardson's mathematical models are not directly testable and Newcombe's analyses are not based on accurately specified models. Despite these shortcomings, the variable is important enough to be included in the equation for military expenditure while its exact form is subject to change during the course of the project.[17]

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[16] It has been suggested by some students of international relations that alliances decrease defense expenditures since they constitute a sharing of defense burden and defense or security takes the form of a "public good." Empirical evidence for this assertion is not easy to obtain. The U.S.-Japanese security treaty may have enabled Japan to "pay" less for its defense, but most other countries that are in alliances with superpowers tend to spend more on defense. This observation, however, could be due to other factors and may in fact be spurious. Other possibilities shall therefore be kept in mind during the course of the project. Another problem worth noting is that the relationship between alliances and conflict is not quite clear (Beer, 1970).

[17] For other variations of this relationship see Abolfathi and Park (1975).

Another term in the equation for defense expenditure that needs some explanation is the defense expenditure of rival or adversary nations. This term becomes important when two or more nations "engage" in an arms race. There are many possible forms of arms races, each of which may depend on a large number of factors.[18] The preliminary equation in this project will be a simple additive model in which the annual increase in arms expenditure of each nation is assumed to be in part a function of the average increase in the defense expenditure of its rival nations. "Rival" nations were selected on the basis of historical rivalries, border and territorial disputes, and other major forms of conflict of interest. Therefore, as the enemies, or adversaries, of a nation increase their defense expenditures, the intensity of the arms race should correspondingly increase.

The other notable terms in the equation are U.S. and Soviet arms transfers and military aid. Arms transfers from superpowers are relevant because they not only reflect the direction of a nation's "Cold War" alignment but are also important factors in stimulating demand to more and better armaments and increasing the future capacity of the nation for "absorbing" advanced weapons systems.[19] Military aid is included because it has been an important source of defense capability in many countries aligned with the United States.[20]

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[18] See Intriligator (1964) and Busch (1971) for different models of arms races.

[19] This argument goes as follows: As a Third World nation imports modern armaments (1) it gains more experience in using sophisticated equipment, (2) it acquires a need for complementary and supporting armaments of the same degree of sophistication, and (3) the rival states seek equivalent or more sophisticated weapons. Therefore, as more advanced weapons systems become available, one would expect that importing nations with greater experience with advanced weapons systems would be the first to import them.

[20] It is quite possible that a similar part is played by Soviet military aid to countries such as Cuba, Egypt, Syria, Iraq and Guinea. Such a model is about to be tested where data of reasonable quality are found. See Joshua and Gilbert (1969).

The Military Manpower Equation

The equation for military manpower predicts the number of regular armed forces personnel on the basis of the previous year's force levels, conflict, turmoil, and the annual change in GDP per capita. Military manpower generally changes slowly over time except during periods of very high conflict and turmoil. It can therefore generally be forecast by projecting its past trend. The first term of the equation, previous year's level of military force, is included to account for this over-time stability. The other terms in the equation merely explain the deviations of military manpower from the expected level based on the previous year's level.

$$MILMAN_t = \beta_{10,0} + \alpha_{10,1} MILMAN_{t-1} + \alpha_{10,2} CONFLICT_{t-1} + \alpha_{10,3} TURMOIL_{t-1}$$

$$+ \alpha_{10,4} \Delta \frac{GDP}{POP}_{t-1,t-2} + \beta_{10,5} \left(\frac{\sum_{i=1}^{5} MILAID_{t-5}}{5} \right)$$

It is assumed that both conflict and turmoil increase military force levels. Note, however, that wealth (GDP per capita) may or may not lead to increases in armed forces. If it is assumed that lack of wealth is a constraint on building larger armed forces, then as a nation becomes wealthier its armed forces should increase. Wealth is also an indicator of the level industrialization, technology, and organizational-administrative capability. Therefore it is quite possible that as wealth increases and technology advances, a nation will devote more of its defense budget to firepower (for example, high technology weapons) and less to manpower. Thus, the size of the armed forces would decrease.

In addition, there are two other factors that mitigate increases in armed forces as national wealth increases. First, wealth is often synonymous with affluence, standard of living, and wage levels. If these variables increase, the cost of military manpower increases.[21] Second, as weapons

[21] Manpower costs also increase as conscription levels are reduced or the conscription period is reduced. These also seem to occur as nations become more affluent (The Economist, 1975).

technology advances, the level of skill required of military personnel increases.[22] This means that the cost of training and maintaining armed forces also increases. Thus, it seems that there are factors that impede increases in the size of armed forces as national wealth increases even though, in general, the lack of wealth can be treated as a constraint on the size of the armed forces.[23] Here, again, the full set of relevant predictors has been included in the model and empirical estimation will determine the direction and strength of relationships appropriate for each region being forecast.

INTERNATIONAL TRANSACTIONS--TRADE

Our description of the economic sector was confined to equations necessary to estimate GDP for each country. Another "economic variable" important outside the economic subsystem is international trade. The previous discussions of imports and exports dealt with aggregate trade; they should not be confused with trade flows between specific countries. The exports and imports discussed thus far represent the size of the foreign sector within the economy. Trade flows between countries must now be specified.

To discuss trade flows, more than one country must be considered at the same time. For convenience, the subscript is dropped from all variables--it is to be understood that all variables are contemporaneous values. Subscripts are now used to identify countries.

Let V_{ij} represent the value of trade flowing from country i to country j. V_{ij} is then country i's exports to country j. The relation of the V_{ij}'s

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[22] See, for instance, Lomor (1973).

[23] On the other hand, as wealth and affluence increase it is quite likely that the scope and intensity of government expenditures in social welfare and education also increase and eventually begin to draw resources away from defense (Sprout and Sprout, 1968, and Russett, 1975).

to the previous variables is direct:

$V_{ij} = M_j$, i = j's imports from all countries in the world, and

$V_{ij} = X_i$, j = j's exports to all countries in the world.

The tentative equation to be used to specify trade flows between countries is:

$$TRADE_{(1,j)_t} = \beta_{8,0} + \alpha_{8,1} GDP(i)_t + \alpha_{8,2} GDP(j)_t + \beta_{8,3} POP(i)_t + \beta_{8,4} POP(j)_t + \beta_{8,5} DISTANCE(i,j)$$

where distance represents a resistance to transactions between i and j.

The GDP's for both countries enter the equation. For the importer, GDP represents an income level to finance purchases. For the exporter, it represents the ability to compete in international markets--the ability to produce for export sale. Population for each country captures the influence of the size of each country's market.

Distance is a "resistance to trade" influence. Transport costs are approximated by distance. Other resistance variables can be introduced by distance. Other resistance variables can be introduced where appropriate. The study team expects to employ dichotomous (or "dummy") variables to capture the influence of membership in a trade preference group such as the Latin American Free Trade Association (LAFTA) or the Andean Subgroup. Additional groupings such as the Organization of Arab Petroleum-Exporting Countries (OAPEC) can be handled in a similar fashion.

A few additional remarks may clarify the difference between the trade values (imports and exports) appearing in the GDP forecasting equations and the trade values described by the trade equation just discussed. As has been noted, the GDP forecasting equations employ total imports and total exports for a particular country. The trade flow equation then employs the forecast values of GDP to forecast the geographic distribution of each country's trade.

The specification of exports to the United States in the GDP equation can be compared to the trade flow equation prediction of the same exports to the United States. Note that any stimulus to a country's GDP is expected to increase that country's exports. If, during a policy analysis exercise, exports to the United States are increased as a result of a favorable U.S. tariff policy, the prediction from the trade flow equation can be used to determine what proportion of increased exports to the United States is attributable to favorable U.S. policy action. This latter proportion is an indication of the political/economic role played by the United States in the international economic relations of Third World countries.

Finally, the trade flow and GDP equations provide complementary checks on the validity of policy-induced increases in U.S. trade levels vis-a-vis Third World countries. By comparing trade as used in the GDP equation with trade flow forecasts, the model can "flag" inconsistent or questionable exogenous changes in U.S. trade policies--where they are questionable in that the analyst has attempted a trade specification inconsistent with the historical record.

INTERNATIONAL ALIGNMENT

The literature on international alignment is extensive and can be divided into two broad analytical categories:

- Treatments of cost and benefits of joining alignments. This literature focuses on the calculations of national decision-makers in assessing the value of joining or remaining in an alliance, coalition, or informal group in the international system. A subset of this literature uses highly formal models and rigorously treats the cost-benefits of alignments using techniques that are usually borrowed from economic literature.[24]

[24] There are hundreds of references in this category of the literature on alliances. Some typical examples are Olson and Zeckhauser (1970) and Sandler (1975).

- Analyses of the structure and environment of alignments. This set of literature generally treats alignments as systems of organization that tend to form (or disintegrate) under certain conditions. The literature focuses on the structural factors (such as distribution of power within alignments) and environmental forces (such as international tension, arms races and conflict) which contribute to the cohesion of alignments.[25]

In this project alignment is conceptualized as consisting of several components that reflect the degree to which a nation is aligned with the two major superpowers. Thus, we are relying largely on the second category of literature. Dyadic (relational) and monadic attributes and behavioral characteristics of each nation are used to measure and forecast alignments with the United States and the Soviet Union. The basic equations that are being used to determine the direction of alignment with the superpowers are as follows:

$$ALTRD\Theta = \%TRDUS_t / (\%TRDSU_t + 1)$$

$$ALARM\Theta = \%ARMUS_t / (\%ARMSU_t + 1)$$

$$ALVOT\Theta_t = \%VOTUS_t / (\%VOTSU_t + 1)$$

where:

$\%TRDUS_t$ = percentage of trade with the United States

$\%TRDSU_t$ = percentage of trade with the Soviet Union

$ALTRD\Theta_t$ = direction of alignment on trade

$\%ARMUS_t$ = percentage of arms trade with the United States

$\%ARMSU_t$ = percentage of arms trade with Soviet Union

$ALARM\Theta_t$ = direction of alignment on arms trade

$\%VOTUS_t$ = percentage of U.N. votes in agreement with the United States

$\%VOTSU_t$ = percentage of U.N. votes in agreement with the Soviet Union

$ALVOTO_t$ = direction of alignment on U.N. votes

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[25] For examples of this type of literature, see Holsti, Hopmann and Sullivan (1973) and Koch, North and Zinnes (1960).

Each of the three equations above represents a different aspect of alignment. $ALTRD\Theta_t$ represents the ratio of a nation's trade with the United States to its trade with the Soviet Union. It is therefore an indicator of economic reliance on the United States versus the Soviet Union. $ALARM\Theta_t$ reflects reliance on the United States (versus the Soviet Union) as an arms supplier. Since arms supplies generally have far greater political significance than other types of economic transactions, they are used here as a more sensitive indicator of international alignments with obvious military overtones. Finally, $ALVOT\Theta_t$ is used as the most insensitive indicator of alignment in international politics since U.N. voting represents a behavior that entails the least amount of commitment and, unlike alignment on trade and arms, its shifts do not involve the great costs incurred by shifting one's military or economic orientations.[26]

The degree of alignment is measured by the following equations:

$$ALTRDR_t = [(\%TRDUS)^2 + (\%TRDSU)^2]^{\frac{1}{2}}$$
$$ALARMR_t = [(\%ARMUS)^2 + (\%ARMSU)^2]^{\frac{1}{2}}$$
$$ALVOTR_t = [(\%VOTUS)^2 + (\%VOTSU)^2]^{\frac{1}{2}}$$

Where: $ALTRDR_t$ = the level of involvement in superpower alignments on trade

$ALARMR_t$ = the level of involvement in superpower alignments on arms trade (impacts only).

$ALVOTR_t$ = the level of involvement in superpower alignments on U.N. voting.

Unlike the previous set of equations which measure the direction of alignments, the above equations measure the intensity with which each nation is involved in alignments with either of the two superpowers.

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[26] Egypt, for instance, has had to bear great costs in trying to reduce its dependence on Soviet arms and Cuba had to endure very high economic burdens in order to shift its economic alignment from the United States to the Soviet Union.

The Alignment Equations

Equations used for predicting alignment are very similar to those used by Leavitt (1971) and CACI (1974). They make use of joint-attributes as well as nation-specific attributes to measure the alignment-proneness of each nation. There are four different equations for predicting alignment on arms trade and U.N. voting.[27]

$$\text{ALARM}\Theta_t = \beta_{11,0} + \alpha_{11,1}\,\text{GDP}_t + \beta_{11,2}\,\text{BLOC} + \beta_{11,3}\,\text{USCOOP}_t + \beta_{11,4}\,\text{SUCOOP}_t + \alpha_{11,5}\,\text{ALARM}\Theta_{t-1} \quad (11)$$

$$\text{ALVOT}\Theta_t = \beta_{12,0} + \beta_{12,1}\,\text{GOVTYPE} + \alpha_{12,2}\left(\frac{\text{GDP}}{\text{POP}}\right)_t + \beta_{12,3}\,\text{BLOC} + \alpha_{12,4}\,\text{ALTRD}\Theta_t + \alpha_{12,5}\,\text{ALARM}\Theta_t + \beta_{12,6}\,\text{USCOOP}_t + \beta_{12,7}\,\text{SUCOOP}_t + \beta_{12,8}\,\text{RELAID}_t \quad (12)$$

Where: $\text{RELAID} = \frac{\text{USAID}}{(\text{SUAID}+1)}$

$$\text{ALARMR}_t = \beta_{13,0} + \beta_{13,1}\,\text{GOVTYPE} + \alpha_{13,2}\,\text{ALTRDR}_t + \alpha_{13,3}\,\text{TURMOIL}_t + \alpha_{13,4}\,\text{CONFLICT}_{t-1} + \alpha_{13,5}\left(\frac{\text{DEFEX}}{\text{GDP}}\right)_t \quad (13)$$

Where: $\text{ALTRDR}_t = \left[(\%\ \text{TRADUS}_t)^2 + (\%\ \text{TRADUS}_t)^2\right]^{\frac{1}{2}}$

$$\text{ALVOTR}_t = \beta_{14,0} + \beta_{14,1}\,\text{GOVTYPE} + \alpha_{14,2}\,\text{ALTRDR}_t + \alpha_{14,3}\left(\frac{\text{GDP}}{\text{POP}}\right)_t + \alpha_{14,4}\,\text{ALARMR}_t \quad (14)$$

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[27] Because no systematic treatment of alignments of Latin America, Africa, and the Middle East has been carried out by other researchers, it is expected that the alignment equations presented in this report will be substantially modified in order to increase their predictive power. Moreover, as they are, these equations have too many independent variables which will have to be reduced in number. Thus, the present equations are only a first approximation of the final set.

Notice that the equations generally have two common characteristics. First, they all are predicted from certain monadic attributes including government type, economic size (GDP), wealth (GDP per capita), intensity of military expenditure (DEFEX/GDP), domestic turmoil (TURMOIL), or inter-state conflict (CONFLICT). These variables were included in different equations because they either reflect the rationale for joining alignments or the environment which forces nations to join different hostile groups.[28] Second, all equations have predictor variables which represent alignment or relationships of a nation with the superpowers. These included alignments on trade, arms, or U.N. voting, as well as such variables as cooperation (with the United States or the Soviet Union), military bloc membership (BLOC), and relative aid received from the superpowers (RELAID). The rationale underlying these variables is generally straightforward. It is assumed that nations generally attempt to maintain a congruent pattern among their alignments on different dimensions. If certain alignments are out of step with other alignments, decisions shall eventually cause shifts toward increased congruence. For instance, the Egyptian shift on arms trade alignment from the Western suppliers to Communist suppliers was eventually followed by a significant, similar shift in trade and U.N. voting. Which dimension of alignment exactly follows another is difficult to specify. This shall, to some degree, be based on the evidence from different regions and the lagged correlations of different alignment measures.

Finally, two additional measures of alignment are included. The first reflects a nation's total alignment <u>averaged</u>. This equation attempts to assess the extent to which a nation's total alignment activity, in terms of trade, arms transfers, and U.N. participation, shifts over time.

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[28] The list of potential candidates for inclusion as independent variables in the alignment equations is very long. The study team, therefore, had to be somewhat arbitrary in excluding some variables. It is expected, however, that the present equations shall be substantially modified during the course of estimation as a result of technical requirements in the estimation process.

$$ALIGNR_t = (ALARMR_t + ALVOTR_t + ALTRDR_t)/3 \quad (15)$$

$$ALIGNS_t = [(ALTRD0_t - ALARM0_t)^2 + (ALTRD0_t - ALVOT0_t)^2 + (ALARMO_t - ALVOTO_t)^2]^{1/2} \quad (16)$$

This last equation indicates the degree of alignment instability based on the degree of incongruence between all possible pairs of the three alignment measures.[29]

U.S. Impact on LDC Alignment

The structure of the international alignment sector includes several variables that are either indirectly or directly manipulable throughout the forecasting period. Shifts in one form of alignment can be simulated to determine the impact of such a shift on other sectors. For example, the reestablishment of relations between the United States and Cuba would probably mean that international trade between the two countries would increase. This increase would impact on the economic sector of the model, on the international trade sector, and perhaps on other alignment indicators and the domestic and international conflict sectors. Thus, the widespread impact of a decision for rapprochement between the United States and Cuba can be explored in experimental situations to see if such a decision would have negative, long-range effects for U.S. strategic interests.

INTERNAL INSTABILITY

Turmoil

The model developed to forecast turmoil in lesser developed regions is drawn from the theoretical and empirical work of Ted Gurr (1970) in

[29] The rationale for this measure is similar to those found in the psychological literature on the concept of cognitive dissonance.

which civil violence was hypothesized to be a function of relative deprivation, the scope and intensity of beliefs within the population about the justifiability and utility of civil violence, and the balance of organizational and coercive capabilities between dissidents and regimes.

This earlier model ignored the sequential processes by which past domestic conflict affects the propensity for civil conflict. Therefore, highly relevant predictor variables were excluded and some of the relationships among the predictors which were explicitly included were not specified. In response to these problems, Gurr developed a second model which focused on the nation-state as a unit of analysis (Gurr and Duvall, 1972), and which, as a result, is more relevant to and appropriate as a basis for the development of a forecasting model for the regions under analysis.

The Turmoil Equation[30]

The LDC model postulates that civil conflict is a function of strain, stress, the normative and utilization justifications for violence extant within the society, and the balance of capabilities between regimes and dissidents.[31] Employing this formulation, Gurr was able to account for fully 75 percent of the variance in political conflict across 86 developed and developing nations (Gurr and Duvall, 1972: 47).

Equation 17 shows the theoretical forecasting model for turmoil to be tested, estimated, and employed in the current effort. There are substantial differences between this model and the model tested by Gurr and Duvall, most of which stem from the need to employ exogenous predictor variables which can be separately forecast in the larger model. Nonetheless, this representation remains substantively equivalent to the theoretical model tested by Gurr.

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[30] Again, see Appendix 3 for variable definitions and sources.

[31] Strain, in this context, refers to relatively invariant, structural constraints on the distribution of values within societies (limited educational opportunities or political participation). Stress refers to shortages or relative declines in the supply of valued social, economic or political goods (decline in per capita income, unemployment).

$$TURMOIL_t = \beta_{17,0} + \beta_{17,1} STRAIN_t + \alpha_{17,2} \sum_{i=0}^{2} \{ (GDP_{t-i} - GDP_{t-(i+1)}) \} \quad (17)$$

$$+ \alpha_{17,3} \frac{DEFEX}{GDP_t}t + \alpha_{17,4} \frac{MILMAN}{POP_t}t + \alpha_{17,5} \frac{GDP_t}{POP_t} + \alpha_{17,6} TURMOIL_{t-1}$$

where: $STRAIN = \left(\frac{GDP_t}{POP_t} - \%NON_t\right) + \left(\frac{GDP_t}{POP_t} - \%LIT_t\right)$

$$+\left(\%NON - \%URB\right)$$

First, the ratio $DEFEX_t/GDP_t$ represents the extent to which resources are diverted from domestic social requirements to military needs, and thus, given the assumption of resource constraints in Third World nations, reflects the relative position of unmet domestic social needs. This form of STRAIN is supplemented by a second construct representing the aggregated absolute values of disequilibria between per capita income, job skills, education levels, and urbanization. This variable captures the differential rates of development along multiple dimensions that can cause needs generated in one sector to be unmet because of insufficient capabilities in other, related sectors of the society. Taken together, these operational variables reflect the kinds of long-term, relatively fixed structural constraints within society that tend to militate against the fulfillment of social needs.

As noted above, stress refers to shortages, or relative declines, in the supply of social values. Stress is represented by two operational referents, GDP_t/POP_t and the three-year aggregation of short-term changes in gross domestic product (GDP). Per capita gross domestic product is used here as an indicator of the total level of social values available in the society. Admittedly, this measure explicitly taps only economic values. Political stress is not measured directly. However, two other variables--$DEFEX_t/GDP_t$ (one of the STRAIN measures) and $MILMAN_t/POP_t$ (a measure of suppressive capability) are among those used by Gurr to measure political stress. Military manpower, as a proportion of total

available manpower, indicates the diversion of these capabilities from social requirements to suppressive interest, at least as that term is used in the context of the domestic unrest model.

The second operationalization of the stress variable, the three-year aggregation of short-term changes in GNP, reflects changes in the supply of valued social goods. As noted above, stress refers both to the overall level of available social goods and to short-term changes in the level of available social goods; this second indicator of stress is used to tap the latter aspect of that concept.

The third predictor of civil conflict employed in the Gurr model is the normative and utilization justification for violence within the society. Since this concept is not directly measurable on a societal level, indirect indicators, such as past-observed behaviors in the society, must be employed. Thus, past levels of turmoil are used to represent the observed behaviors that indirectly indicate justifications for civil violence. The use of this particular indicator assures that values for TURMOIL will be available for generating forecasts of turmoil in a society at future points in time.

Finally, the 1972 Gurr model postulates that civil violence is a function of the balance of capabilities between regimes and dissidents. While an ideal operationalization of this concept would include both regime capabilities and dissident capabilities, forecasts of the latter require data not available today in any published collection. This concept is imperfectly captured by an indicator of regime capabilities, $MILMAN_t/POP_t$. As a result, the model specified here is likely to account for somewhat less variance in domestic unrest than did the original Gurr model.

Two comments regarding the measurement of conceptual variables are in order at this point. First, Gurr's actual data for the magnitude of political conflict within societies are used. This variable was derived from coded data on the properties of civil strife events recorded in the

New York Times and other sources (Gurr, 1968). These events were specifically political in character, that is, there were political motives and/or targets associated with them, and they were focused internally. The TURMOIL variable is measured by (1) summing the man-days of participation in all reported domestic conflict events for a country, (2) multiplying the reported number of non-governmental participants by the event's duration in days, (3) weighting summed man-days by the nation's population, (4) summing the deaths reported for all conflict events and weighting deaths by the nation's population. Man-days and deaths are then combined by adding a constant of 0.1 to each country's score on each measure, taking the base 10 logarithm of the result, z-scoring the logged measures and adding the two distributions of z-scores. Further discussion of the validity and reliability of the resulting data can be found in Gurr (1968).

The second aspect of the measurement problem is that variables derived from the larger forecasting model have been used to represent the predictors identified and tested by Gurr and Duvall. While in some cases the identical operational variables have been used, in other cases this was not possible and substitutes which could be generated by the larger model were sought. As a hedge against possible distortions resulting from this substitution process, an effort was made to apply multiple operationalizations to each conceptual variable. While this process cannot, of course, insure the validity or reliability of the resulting measures, much previous research (Campbell and Fiske, 1959 and Janda, 1971) suggests that multiple operationalism militates against validity and reliability problems associated with the use of single indicators.

Military Coups d'Etat

Military coups have been the subject of much attention in the literature on LDC's. This is in part due to the increasing frequency of coups in Africa, Asia, Latin America, and the Middle East. There are very few developing countries in which coups are unlikely. Nevertheless, research indicates that there are definite patterns to the occurrence of coups.

Military coups tend to occur in some countries more than in others. Singapore, Lebanon, Taiwan, Mexico, and Tanzania are countries which have in the past seemingly been immune to such phenomena whereas Bolivia, Syria, Laos (before the Communist takeover), and Mali seem to have high propensity for military intervention in government. Also, most industrialized and all Communist countries seem to be completely free of the dangers of military takeovers.

Coups tend to occur more frequently during periods of economic recession, high inflation, military defeat, and national turmoil. However, they are less uncommon in traditional societies where political institutions have not been disrupted by war, colonialism, economic development, or natural disasters such as drought and famine. They tend to be more prevalent in societies experiencing rapid change, growth, recovery, or other forms of transition.

Students of domestic conflict and irregular government change have been able to identify some of the conditions that increase or decrease the probability of coups. Blondel (1969), in his study of military intervention in government, states that the probability of an intervention is increased as:

(1) The degree of professionalization of the military increases;

(2) The extent of the legitimacy of the political system decreases;

(3) The level of the complexity of the society decreases;

(4) The tension between the military ideology and the prevailing ideology embodied by the political system increases (Blondel, 1969: 417).

Blondel demonstrated that if one could assume that the above factors have equal weight, then the relationship between military intervention and socio-economic development would first be positive and then become negative. This is to say, countries at the beginning and end of a development spectrum have the lowest probabilities for the occurrence of military

coups, while those in the middle, the transitional countries, have the highest (Park and Abolfathi, 1974).

Other hypotheses that have found support through empirical analysis of coups are:

(1) Coups tend to occur more frequently in countries that have a history of coups.[32]

(2) Coups tend to occur more frequently in periods of natural turmoil and economic difficulty.[33]

(3) Coups tend to occur more frequently in countries where the government capabilities for mobilization and control of the populace are low and where the governmental legitimacy is wanting.[34]

The Coup Propensity Equation

The coup propensity equation attempts to capture empirically the various forces that appear to influence coups in LDC's.[35]

$$COUPS_t = \beta_{18,0} + \alpha_{18,1} \sum_{i=1}^{10} COUPS_{t-i} + \alpha_{18,2} \left(\frac{\sum_{i=0}^{2} (GDP_{t-1} - GDP_{t-(i+1)})}{\sum_{i=0}^{2} (POP_{t-1} - POP_{t-(i+1)})} \right)$$

$$+ \alpha_{18,3} TURMOIL_t + \beta_{18,4} \left(\frac{\sum_{i=1}^{5} MILAID_{t-5}}{5} \right) + \alpha_{18,5} \left(\frac{GDP}{POP} \right)_{t-5} \qquad (18)$$

Where: MILAID consists of two variables, U.S. and Soviet military aid to an LDC.

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[32] See Finer (1974), Ben-Dor (1975), Park and Abolfathi (1974).

[33] See Huntington (1968: 192-263) and Hibbs (1973).

[34] See Huntington (1968), Blondel (1969), Park and Abolfathi (1974), Fossum (1967), Schneider and Schneider (1971), Hibbs (1973).

[35] It should be noted that this approach to predicting coup propensity has been criticized by some authors but the alternative approaches have not proved as viable. See Midlarksy and Tanter (1967) and Midlarsky (1970, 1975).

The first determining variable in the equation essentially asks how many coups occurred during the preceding 10 years. This information determines the degree of historical coup proneness of each nation. The next term in the equation is a measure of recent growth in income per capita. The growth figure for the preceding five years is aggregated and used as a measure of the recent economic growth trends of the nation. The third term in the equation, TURMOIL, is used as an indicator of domestic tension in the country. It is assumed that countries that are undergoing a great deal of domestic conflict would have a greater propensity to experience military coups d'etat. The fourth term in the equation is military aid for the preceding five years. This term represents the alleged relationship between military aid and coup proneness of Third World countries.[36]

The last term in the equation relates to the level of development of the country. It is expected that the relationship will be found to be nonlinear, as was described earlier. In order to take into account this nonlinearity, the data shall be analyzed in two different subsets for each region: (1) subset of countries that have not reached the level of $800 GNP per capita, and (2) subset of countries that have passed $800 per capita level. The first subset is expected to exhibit a positive relationship between coups and GNP per capita, whereas the second subset is expected to have a negative relationship. It is not expected that this relationship would be instantaneous. Therefore, a five-year lag was introduced as a reasonable delay time for the relationship to become effective.[37]

The equation for the coups is a comprehensive representation of a major portion of the state of literature on the subject. It cannot incorporate every piece of information found in the literature because of (1) data unavailability, (2) technical difficulties, and (3) the fact that not all the findings in the literature are consistent. Moreover, coups are events that

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[36] This relationship has found some statistical support in the work of Schmitter (1973), Park and Abolfathi (1974), and Rowe (1974). These statistical relationships, however, could be spurious and require very cautious interpretation.

[37] This five-year lag, like most other lags and aggregation periods, is largely based on area expert judgments. It should, therefore, be treated as only a tentative estimate and subject to later change.

occur occasionally in coup-prone countries. The probability of a coup in a given country can be roughly estimated as the probability of occurrence given that a number of preconditions exist. Beyond this, even at the conceptual level, there is very little that can be said. A coup event can never be predicted in long-range forecasts, nor for that matter can any other probabilistic event. In this project, therefore, the term coup shall refer to either (1) expected number of future coups (in terms of frequency over a period of time) or (2) the actual number of coups experienced during some period in the past.[38]

INTERNATIONAL CONFLICT BEHAVIOR

Conflict

The conflict model for three regions in this study is an expanded and more sophisticated version of the model developed in CACI (1974). The earlier model, developed for the European region, was designed to forecast the international conflict behavior of a relatively homogeneous group of nations. At the same time, the earlier model ignored the specific influence of the United States and the Soviet Union on the conflict behavior of the nations in the model. In contrast, the present conflict equation explicitly attempts to capture the tone of U.S. and Soviet behavior and, in turn, enable the evaluation of the impact of that behavior on a nation's conflict.

The Conflict Behavior Equation

In the conflict equation, the dependent variable, international conflict behavior, is conceptualized in the same manner as in the European study. This is to say, conflict is treated as a subset of the flow of interactions among nations that indicate the degree of hostility, including both verbal actions (such as protests, warnings, and threats) and acts of a physical nature (such as armed attacks, military engagements). Underlying this

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38 In this project no attempt shall be made to forecast extensively the impact of coups. The few studies that have attempted to do so have not been very successful. See Ames (1975), Hibbs (1973), Park and Abolfathi (1974), and Schmitter (1973).

operationalization is the assumption that international conflict tends to be a unique dimensional phenomenon: for example, conflict is conceived of as a continue such that small-scale disruptions and negative verbal interactions of a limited scope and impact fall at the lower end, military or violent conflict falls at the upper end, and conflict behaviors of increasing intensity and magnitude fall in between. As in the European study, operational measures of conflict are drawn from the World Event/ Interaction Survey (WEIS) (see CACI, 1974: 353-365).

In this year's effort, hostile interactions among governments or their representatives are weighted, aggregated, and measured in log (base 10) form to provide a composite conflict behavior variable. This operationalization is identical to that employed in the earlier European study. The specific WEIS categories included in the analysis and their respective weights are shown in Table 2. The categories of conflict events listed in the table vary considerably in intensity, ranging from mild verbal criticism to violent encounters. Weighting each category of events prior to the aggregation process creates a single conflict behavior index to each of the 64 LDC's which reflects critical differences and intensity among various types of conflict behavior.

Equation 19 shows the forecasting model for conflict behavior that is to be tested, estimated, and employed in the three regions. In contrast to the European conflict equation, eight predictor variables are included: conflict, defense expenditure by itself as well as relative to gross domestic product, turmoil, the intensity and direction of alignment in arms transfers, and cooperative behavior received from both the United States and the Soviet Union.

$$\begin{aligned} CONFLICT_t = {} & \beta_{19,0} + \alpha_{19,1}\, CONFLICT_{t-1} + \beta_{19,2}\, DEFEX_t + \alpha_{19,3}\left(\frac{DEFEX}{GDP}\right)_t \\ & + \alpha_{19,4}\, TURMOIL_t + \alpha_{19,5}\, ALARMO_t + \alpha_{19,6}\, ALARMR_t \\ & + \beta_{19,7}\, USCOOP_t + \beta_{19,8}\, SUCOOP_t \end{aligned} \qquad (19)$$

This equation differs substantially from that employed to forecast European conflict behavior. The current equation attempts to reflect the impact of both domestic and international forces on a nation's behavior. Following the insight of Wright (1965) and Richardson (1960), past wars and conflict are included as important determinants of the likelihood of future violence between nations. The Wright and Richardson analyses emphasize the war proneness of nations and reflect a substantially narrower conceptualization of conflict than employed here. The current operationalization includes verbal conflict behavior as well as physical hostility and follows the works of Wilkenfeld and Zinnes (1971) which suggest that a nation's total foreign conflict during a given year is positively and highly related to its level of conflict behavior in the previous year.

Defense spending also appears to be a strong predictor of conflict behavior. This variable appears in much of the theoretical and empirical work that attempts to explain the onset of war. Defense expenditure is an indicator of the degree to which nations are preoccupied with military affairs. The absolute level of defense expenditure, the second term in the conflict equations, indicates the relative military power of a nation. Several theorists, including Singer (1972) and Rummel (1968), have found that strong military powers tend to become involved in conflict situations more often than do weaker nations. In addition, Richardson (1960a) and Weede (1970) found a strong positive relationship between defense spending as a percentage of the gross national product of nations and their tendency to become involved in verbal and physical conflicts. Therefore, both the absolute and relative values of defense expenditure were included as independent variables. A number of theorists including Simmel (1955), Wright (1965) and Rosecrance (1963) argue that there exists a linkage between domestic and foreign conflict behaviors of nations. While early quantitative research cast doubt on this arguement, Wilkenfeld (1973) found some evidence of a relationship between domestic and foreign conflict after he had controlled for the type of regime in his sample of nations. Wilkenfeld (1973) also suggests that high levels of alignment may increase governmental legitimacy, thus lessening internal strain, so that the linkage between domestic and foreign conflict may be particularly strong when alignments with major powers are

TABLE 2

Relationship Between WEIS
Event Categories and Aggregated Classes

Aggregated Classes	WEIS Event Categories
1. Physical Conflict Weight = 1.0	seize position or possessions military engagement
2. Coercion Weight = 0.5	issue order, insist on compliance give warning
	threat without specific negative sanctions
	threat with specific military negative sanctions
	threat with force specified
	ultimatum, time limit specified
	military mobilization, exercise, or display
	break diplomatic relations
	order personnel out of country
	expel organization or group
	detail or arrest persons
3. Pressure Weight = 0.35	turn down proposal, reject protest, etc.
	refuse, oppose, refuse to allow
	charge, criticize, blame
	denounce, denigrate, abuse
	informal complaint
	formal complaint or protest
	deny an accusation
	deny an attributed policy, action, or position
	cancel or postpone planned event
	reduce routine international activity
	reduce or halt aid
	halt negotiations

weak. The degree and direction of the most politically sensitive alignment component, alignment in arms transfers, is included in the conflict equation in an attempt to assess the impact of dependency on either the United States or Soviet Union for military hardware. In addition, since these variables can be manipulated through conscious changes of policy, they allow alternative forecasts to be generated once the regional models have been constructed. Finally, two additional variables are included which attempt to capture the impact of U.S. and Soviet cooperative behavior on monadic conflict. Although the signs of the parameters are indicated to be positive in the equation, the assumption is that cooperative behavior should serve to dampen the conflict proneness of a nation.

Tension Ratio

We noted above that the conflict behavior variable operationalized from WEIS data included verbal as well as physical conflict behavior. In fact, the distribution of events across the three aggregated classes of conflict is such that verbal conflict dominates the operational measure. National security planners, particularly Department of Defense planners, however, have a special concern for the physical portion of the conflict behavior spectrum. The Tension Ratio equation, then, is intended to supplement the conflict behavior equation by providing a forecast of the propensity of nations to become involved in specifically physical (for example, military) conflict.

The Tension Ratio Equation

The Tension Ratio design is drawn from the works of Newcombe, et al. (1969, 1972a, 1972b, 1974a, 1974b, 1975). In the course of their research, Newcombe and associates have altered slightly the manner in which the Tension Ratio is developed, using per capita values of gross national product and defense expenditures rather than raw data on these measures. In this report their later formulations shall be used since these are reported to give better results (Newcombe, 1975). The work of Newcombe and associates

is based to a large extent on studies of arms races (Richardson, 1960a; Smoker, 1963, 1965; and Wolfson, 1968) except that the nation is treated as a monad so that the dyadic partners in the arms race need not be identified. The Tension Ratio itself is based on the proposition that nations that devote an unusually high proportion of their resources to the military are more likely to employ those resources directly in the attainment of foreign policy objectives than are nations that devote less resources to the military.

Operationally, calculation of the Tension Ratio first requires development of a measure of "expected" resources devoted to the military given the resources at a nation's disposal. Newcombe and associates obtained this measure by regressing per capita defense expenditures on per capita gross national product and using the predicted values of defense expenditures per capita. In the current model, gross domestic product (GDP) replaces gross national product to maintain consistency with the overall forecasting model, giving the regression equation:

$$\left(\frac{\overline{DEFEX}}{POP}\right)_t^{39} = \left(\beta_{20,0} + \alpha_{20,1}\frac{GDP_t}{POP_t}\right) \qquad (20)$$

Where: $\frac{\overline{DEFEX}}{POP}$ is the predicted value of

$\frac{DEFEX}{POP}$ when regressed on $\frac{GDP}{POP}$

"Expected" resources devoted to the military, then, are calculated as:

$$\overline{DEFEX} = POP\ (\beta_{20,0} + \alpha_{20,1}\frac{GDP_t}{POP_t}).$$

With the estimates of defense expenditures, the Tension Ratio itself can be calculated using the formula

$$TR_t = 100 \times \frac{DEFEX}{\overline{DEFEX}}. \qquad (21)$$

---

[39] This symbology is employed to identify the estimated value of $\frac{\overline{DEFEX}}{POP}$ (defense spending per capita).

TR_t is interpreted as indicating the propensity for a nation to become involved in military conflict, rather than a probability or any other bounded measure. The higher the Tension Ratio, the greater the relative allocation of resources to the military and the higher the propensity for the nation to become involved in military conflict behavior. It is intended that this measure provide a validity check for the WEIS-derived conflict equation in addition to being an alternative measure of conflict propensity for the forecasts.

CHAPTER 4: ESTIMATION PROCEDURES

The models developed to forecast the long-range LDC environments describe the important relationships that have been identified for the general LDC case. It should be reemphasized that many of the relationships presented in the models remain hypothetical at this point. This is to say, a variable has been included in a model not because its inclusion has been substantiated empirically elsewhere but because it is believed to be an important predictor of a specific LDC attribute or behavior. Whether its presence in the model is useful remains an empirical question until each of the individual LDC equations is tested and the analysis evaluated.

The testing of the LDC equations will rely on two forms of "least squares" estimation techniques, ordinary least squares (OLS) and two-stage least squares (2SLS) (see CACI, 1973: 46-52 and Wannacott and Wannacott, 1970: 190-192, 358-364).

Ordinary Least Squares

Most of the LDC equations will be tested using OLS which employs the following form.

$$\underline{Y} = X\underline{\beta} + \underline{\varepsilon}$$

where: $\underline{Y}$ is a txl vector of observations on the dependent variable;

S is a txk matrix, t observations for each of k independent or predictor variables;

$\underline{\beta}$ is a kxl vector of coefficients; and

$\underline{\varepsilon}$ is a disturbance term encompassing the stochastic specification necessary for statistical tests.

The above equation is the true, or population, equation expressing the variable y as a linear combination of the x's. The problem is that the elements of the $\underline{\beta}$ vector are unknown. The OLS estimator of $\underline{\beta}$ is constructed as:

$$\underline{b} = (x'x)^{-1}x'\underline{y}$$

employing only observed, sample information.

Thus, the hypothesized relationship between the descriptors (Y_{txm}) (that is, the dependent variables) and predictor variables (x_{lxn}) can be assessed. It is entirely possible that portions of the (x) matrix will explain more variance in one region than in another. Taking this information into account, the analyst can delete unimportant or inconsequential variables from the models. This procedure is appropriate for it will allow an equation (that for predicting defense expenditure, for example) to differ from region to region thereby more accurately reflecting the diverse nature of each region more realistically.

Two-Stage Least Squares (2SLS)

Two-stage least squares (2SLS) will be used to test the equations of the economic sector of the LDC regions. 2SLS is an estimation technique that is used to estimate parameters for a system of equations (for example, the entire sub-set of LDC economic equations). 2SLS gets its name from the way it works; OLS is used two times to produce 2SLS parameters.

But, for 2SLS to be appropriate, two dependent variables must appear in each of two equations,[1] for example:

$$\alpha_{11}y_1 + \alpha_{21}y_2 + \beta_{11}x_1 + \ldots + \beta_{k1}x_k + \varepsilon_1 = 0$$

$$\alpha_{12}y_1 + \alpha_{22}y_2 + \beta_{12}x_1 + \ldots + \beta_{k2}x_k + \varepsilon_2 = 0$$

[1] The choice of "two" variables and equations is for expositional convenience and should not be confused with the "2" of 2SLS.

or in matrix notation:

$$y\Gamma + XB + U = 0$$

where, in this example:

Y is a tx2 matrix of dependent variables (t observations, 2 variables),

Γ is a 2x2 matrix of coefficients,

X is a txk matrix of independent variables,

B is a kx2 matrix of coefficients,

U is a tx2 matrix of disturbance terms.

The problem is to estimate the elements of Γ and B. Only in very special conditions can OLS be employed to solve a problem of this type. In essence, OLS cannot be employed because both y_1 and y_2 appear in each equation. The 2SLS procedure treats one equation at a time in the following manner. First, consider the first equation and assume y_1 is "explained" in that equation. Employ OLS to regress y_2 on the columns of the X matrix that have zero coefficients in the first equation.[2] Calculate the predicted values of the y_2 variable generated by the regression. Then employ these predicted values in place of the observed values for y_2 together with the remaining columns of X in a second OLS problem to estimate coefficients. This two-stage process generates superior coefficient estimates compared to direct OLS estimates.

Two-stage least squares is more appropriate for estimating parameters for sets of equations that are overidentified; that is, no unique solution can be found. A look at the equations for the LDC economic sector in Appendix 2 reveals that this set meets this criterion. Some of the variables in the set are endogenous to the set and others, such as DEFEX and POP, are exogenous. 2SLS permits the use of estimates of endogenous variables based on exogenous predictors to be utilized in the estimation of parameters in subsequently treated equations. OLS is used for deriving parameters in the second stage. The initial estimation of

[2] Information concerning the zero value of some elements of the B matrix is developed theoretically.

endogenous variables reduces the oversupply of variables to the right number so the resulting set of simultaneous equations can be estimated using OLS.

CHAPTER 5: SUMMARY

The preceding discussions have presented the LDC regional forecasting models currently being developed to improve JCS/J-5 long-range estimation of future needs regarding strategic policy and planning. They have attempted to reveal the specific demands made by forecasting the regions of Africa, Latin America, and the Middle East in terms of their individual and collective differences, their differing importance economically, politically, and militarily to the United States and the Soviet Union, and their growing importance vis-a-vis U.S. defense planning.

Further, this report has described the rationale behind the expanded complexity of the current models compared to earlier research. This complexity is not only demanded by the nature of the LDC regions themselves but by CACI's expressed intent to be responsive to the long-range forecasting needs of JCS/J-5. Both of these concerns have resulted in the development of a 21-equation, interactive forecasting model for each of the developing regions in which:

- Many key variables are measured in such a way as to reflect change in a nation's value on the forecast variables.
- The equations include variables that capture the influence of the United States and the Soviet Union on the behavior of the LDC's in each region.
- The model, although a general model for LDC's, is built in such a way that unique forecasting models can be constructed for each of the three regions.

Thus far, with the completion of Tasks I and II, CACI has made progress in the following areas.

- Three less developed regions have been defined in consultation with JCS/J-5 personnel and the members of each region have been specified (see Appendix 1).

- The set of forecast variables has been expanded and modified to take into account substantive regional peculiarities of both the lesser developed regions and the five broad forecast concepts.

- A new approach to measuring alignment has been developed in which arms flows, trade, aid, and U.N. voting are included in order to capture the complexities of international political orientations in the less developed regions. Also included is a measure that takes alignment incongruities into account.

- Several national power variables have been added to capture more realistically the complex processes of economic, political, and social development.

- Turmoil has been defined in terms that better represent popular discontent and unrest in Third World countries and a coup propensity indicator has been developed to measure the extent to which a country is prone to irregular government change.

- A Tension Ratio variable has replaced dyadic conflict frequencies to represent the propensity for military conflict among less developed countries.

- A set of 21 theoretical forecasting equations has been developed in consultation with JCS/J-5 personnel.

- A set of exogenous predictor variables, including arms transfers, trade, foreign aid, and military aid, have been included in the variable set. This improvement permits the analyst to move from assumptions about no change in outside influences to the point where various assumptions about the impact of outside influences can be tested.

The preceding chapters have continually stressed CACI's efforts toward enriching the forecasting models developed for JCS/J-5. The current

project has relied upon three approaches to this enrichment: (1) increasing the number of variables used to make the five central environmental descriptors and their predictors operational, (2) increasing the number of equations that comprise the overall LDC forecasting model, and (3) introducing manipulable exogenous predictor variables that allow the impact of U.S. and Soviet behavior on the LDC regional forecasts to be assessed.

This latter innovation is the first attempt to capture the impact of superpower behavior on forecast environments. The capability provided by the addition of exogenous variables of this type paves the way for refinements that should eventually be incorporated into JCS/J-5 forecasting capability. For example, the current study only includes the United States and the Soviet Union. Eventually, in anticipation of the increasingly polycentric international environment, other "poles" should be included. The addition of other major actors (China, Japan) or groups (the European Community, the OAPEC) will permit the impact of numerous influences in international relations to be evaluated for their implications regarding strategic policy and plans.

These changes would permit the forecasting outcomes to represent better the wide variation in environmental variables in the LDC regions. However, such an approach is limited; it is still an oversimplification of relationships and results in the loss of extremely valuable information. Alternative methods that would improve the quality of the forecast are now becoming part of "the state of the art." These new methods would make explicit specific characteristics of the LDC's that influence their behavior and progress and inevitably have implications for U.S. and DoD policy and planning.

The configurations of the social, political, and economic dimensions in the LDC's at any given time in many instances result from political decisions by national leaders. It is becoming increasingly apparent that in the LDC's, developmental change and governmental policy are almost inextricably linked. Although it is possible to enrich the forecasting

equations to represent both the range of developmental configurations likely to be found in LDC regions for a 20-year period, the generation of forecasts for a given country can be improved substantially by identifying current policy the probability of a shift in policy, and the most probable direction of a shift. In this way, DoD planners and policy-makers can understand the intricacies of the LDC's and their interrelationships so that realistic boundaries for strategic and tactical operations requirements can be developed. In short, the LDC forecasts can become an invaluable tool for evaluating the linkage between alternative futures and DoD requirements for dealing with such futures.

The forecasting models presently being developed for Latin America, Africa, and the Middle East would be dramatically improved by innovations designed to maximize their ability to represent the subtle realities of the less developed nations. One such innovation involves developing essentially unique models for each nation, or for at least relatively small groups of highly similar countries. The second innovation involves the development of alternative submodels which would introduce a capability to forecast a range of alternative futures, and in turn provide the basis upon which to evaluate alternative strategic policies and plans. Using these devices, planners and analysts (1) assess the impact of discontinuous changes in the relationships among variables for a particular country within alternative models for each nation and (2) assess the meaningfulness of shifting or changing structures in the LDC regions for strategic policy and planning by a disturbance mechanism.

There are several ways of developing country-specific forecasting models. One involves developing different forecasting equations for each forecast variable for <u>each</u> of the nations included in the study. While this option would ensure the greatest realism and maximize the variability of forecast outcomes, it would also involve the greatest costs. A more practical approach to developing country-specific models involves generating a common set of forecasting equations and estimating separate parameters for each country from time series data. To the extent that selected parameters could be analytically set equal to zero for specific nations,

this option approaches the development of different equations for each nation. A third approach includes the best features of both of the above strategies. By combining nations into small, similar groups and developing group-specific parameters for the forecast equations, specificity is preserved and cost is minimized. Thus, different representations of economic behavior could be developed for small sets of countries so that separate parameter estimates could be developed for each group. Likewise, group-specific forecasting equations and parameter estimates could be developed for the most important and most volatile variables in the forecasting model while the remaining equations are developed on a generalized, regional basis.

There are also a number of approaches to the problem of representing alternative futures for the LDC's and systematically relating those alternative futures to sudden or discontinuous changes in the relationships among forecast variables within specific nations. A set of endogenous disturbance mechanisms fed by the macro-model can be built into the current LDC model in order to expand the range of probable futures and to allow planners increased latitude and flexibility in identifying future requirements. As suggested above, one substantive explanation for alternative plausible futures lies in the sensitivity of the development process within any given country to political realities. For example, leadership changes, particularly when new leaders hold different views about the priorities of development along various dimensions, can produce dramatic shifts in the linkages among environmental variables. The shifts in domestic economic policy under the Allende government in Chile -- namely, income redistribution and state ownership of capital -- represented a different path toward development than had previously been followed in that country, and also had important international political consequences. A second mechanism that can generate over-time variability in the linkages among variables might monitor changes in the distribution of public and private spending or changes in the importance of particular raw materials for development. This factor can be particularly important when a nation depends on export revenues of some commodity, such as oil, to finance

development projects (for example, Iran and Saudi Arabia). In this case, the contribution of that revenue to development constrains the nation's political actions in the international sphere because of the implications of possible negative sanctions for the development process. Third, changes in the nature of competition among major powers for management of the Third World and its resources can change the patterns of relationships among environmental variables within Third World nations. This relationship can also be monitored.

There exist, in short, complex and changing relationships between the economic and political variables that constitute a nation's environment, with causal links running from both the economic to the political variables and from the political to the economic variables. In Europe, political stability and similarity in economic structure allowed the construction of a forecasting model that examined the associations among the economic and political variables, with limited emphasis on explicit causal relationships. Simplifying the causal linkages between the economic and political sphere in this way permitted the development of a useful forecasting model for Europe while the methodologies themselves were being explored and developed. The LDC regions, on the other hand, are in a constant state of flux.

- LDC's have a history of political instability and discontinuity of government policy that prevents the identification of standard political responses to economic developments;
- Foreign investment and various strategic raw materials play a much greater role in the growth of LDC's, as a rule, than they do in the developed nations;
- The structures of LDC's are undergoing revision across a number of dimensions, and political forces can have a major impact on the development process in these countries; and
- The changes in the nature of the competition among major powers for clients within the LDC's can have a greater effect upon the nations in those regions than upon more developed countries.

This last characterization presents an exciting possibility that can build on the current LDC model and advance JCS/J-5 long-range forecasting far beyond its present state. With the inclusion of additional principal actors, models can be built that allow hypothetical competitive situations (for example, U.S. vs. Japanese economic interests in Asia) to be evaluated for their impact on international relations in an appropriate region (East, Southeast, South or all Asia, for example). By improving the forecasting models in this way, the interactive effects of great power behavior on the future global or regional environments could be better understood.

Thus, the development of capabilities to represent the variability in relationships among important environmental descriptors and the way that variance is associated with great power behavior will add substantially to the degree to which Third World forecasting models are realistic representations of those environments. The degree to which a forecasting model generates realistic expectations about the nature of the future environment for the planner determines its usefulness within the policy planning context. Moreover, realistic expectations are crucial for (1) strategic planning, (2) evaluating future military capabilities (for example, operations, research and development, intelligence in general; and force structures, air and sealift capabilities, and telecommunications requirements in particular), and (3) examining in advance the impact of alternative defense policy actions. Thus, the kinds of capabilities described above would contribute substantially to meeting identified planning needs in geographic areas where U.S. strategic and tactical interests are expected to remain significant in the future.

The current study, then, is one step toward the fully evolved forecasting/planning model. The growing complexity of the international environment demands that increasingly sophisticated models be developed to assist the defense planner in comprehending the overwhelmingly intricate nature of the future international system in which correct decisions must be made.

APPENDIX 1

COUNTRY LIST

Latin America n = 20

Argentina
Bolivia
Brazil
Chile
Colombia
Costa Rica
Cuba
Dominican Republic
Ecuador
El Salvador
Guatemala
Haiti
Honduras
Mexico
Nicaragua
Panama
Paraguay
Peru
Uruguay
Venezuela

Middle East n = 15

Algeria
Egypt
Iran
Iraq
Israel
Jordan
Kuwait
Lebanon
Libya
Morrocco
Saudi Arabia
Sudan
Syria
Tunisia
Yemen

Africa n = 30

Burundi	Mali
Cameroon	Mozambique
Central African Republic	Niger
Chad	Nigeria
People's Republic of Congo	Rhodesia
Dahomey	Rwanda
Ethiopia	Senegal
Gambia	Sierra Leone
Ghana	Somalia
Guinea	South Africa
Ivory Coast	Tanzania
Kenya	Uganda
Liberia	Upper Volta
Malagasy	Zaire
Malawi	Zambia

APPENDIX 2

Less Developed Region

Forecasting Model Structure

LESS DEVELOPED REGIONS FORECASTING MODEL STRUCTURE

1. $POP_t = (1+c)\,POP_{t-1}$

   Where c (population growth rates) are taken from extant literature for each country.

2. $CONSUMP_t = \beta_{2,0} + \alpha_{2,1} GDP_t + \alpha_{2,2} CONSUMP_{t-1}$

3. $INVEST_t = \beta_{3,0} + \alpha_{3,1} \Delta GDP_{t,t-1}$

4. $DOMEST_t = \beta_{4,0} + \alpha_{4,1} DOMEST_{t-1} + \alpha_{4,2} GDP_{t-1} + \alpha_{4,3} POP_t$

5. $TIMPORT_t = \beta_{5,0} + \alpha_{5,1} GDP_t + \alpha_{5,2} POP_t$

6. $TEXPORT_t = \beta_{6,0} + \alpha_{6,1} GDP_t + \alpha_{6,2} POP_t$

7. $GDP_t = CONSUMP_t + INVEST_t + DOMEST_t + DEFEX_t + TEXPORT_t - TIMPORT_t$

   Where TEXPORT and TIMPORT consist of exports to the US and imports from the US as separate variables.

8. $TRADE_{(1,j)_t} = \beta_{8,0} + \alpha_{8,1} GDP(i)_t + \alpha_{8,2} GDP(j)_t + \beta_{8,3} POP(i)_t + \beta_{8,4} POP(j)_t + \beta_{8,5} DISTANCE(i,j)$

9. $\Delta DEFEX_{t,t-1} = \beta_{9,0} + \beta_{9,1} \Delta DEFEXA_{t-1,t-2} + \beta_{9,2} USARMS_{t-1} + \beta_{9,3} SUARMS_{t-1} + \alpha_{9,4} \Delta \frac{GDP}{POP}_{t-1,t-2} + \alpha_{9,5} CONFLICT_{t-1} + \beta_{9,6} \left(\frac{\sum_{i=1}^{5} MILAID_{t-5}}{5} \right)$

   Where DEFEXA represents the defense spending of actual or potential adversary nations and MILAID consists of two variables, US and USSR military aid.

10. $$MILMAN_t = \beta_{10,0} + \alpha_{10,1} MILMAN_{t-1} + \alpha_{10,2} CONFLICT_{t-1} + \alpha_{10,3} TURMOIL_{t-1}$$
$$+ \alpha_{10,4} \Delta \frac{GDP}{POP}_{t-1,t-2} + \beta_{10,5}\left(\frac{\sum_{j=1}^{5} MILAID_{t-5}}{5}\right)$$

11. $$ALARMO_t = \beta_{11,0} + \alpha_{11,1} GDP_t + \beta_{11,2} BLOC + \beta_{11,3} USCOOP_t$$
$$+ \beta_{11,4} SUCOOP_t + \alpha_{11,5} ALARMO_{t-1}$$

12. $$ALVOTO_t = \beta_{12,0} + \beta_{12,1} GOVTYPE + \alpha_{12,2}\left(\frac{GDP}{POP}\right)_t + \beta_{12,3} BLOC$$
$$+ \alpha_{12,4} ALTRDO_t + \alpha_{12,5} ALARMO_t + \beta_{12,6} USCOOP_t$$
$$+ \beta_{12,7} SUCOOP_t + \beta_{12,8} RELAID_t$$

Where: $$RELAID = \frac{USAID}{(SUAID+1)}$$

13. $$ALARMR_t = \beta_{13,0} + \beta_{13,1} GOVTYPE + \alpha_{13,2} ALTRDR_t + \alpha_{13,3} TURMOIL_t$$
$$+ \alpha_{13,4} CONFLICT_{t-1} + \alpha_{13,5}\left(\frac{DEFEX}{GDP}\right)_t$$

Where: $$ALTRDR_t = \left[(\%\ TRADUS_t)^2 + (\%\ TRADUS_t)^2\right]^{\frac{1}{2}}$$

14. $$ALVOTR_t = \beta_{14,0} + \beta_{14,1} GOVTYPE + \alpha_{14,2} ALTRDR_t + \alpha_{14,3}\left(\frac{GDP}{POP}\right)_t + \alpha_{14,4} ALARMR_t$$

15. $$ALIGNR_t = (ALARMR_t + ALVOTR_t + ALTRDR_t)/3$$

16. $$ALIGNS_t = \left[(ALTRDO_t - ALARMO_t)^2 + (ALTRDO_t - ALVOTO_t)^2 + (ALARMO_t - ALVOTO_t)^2\right]^{\frac{1}{2}}$$

17. $$TURMOIL_t = \beta_{17,0} + \beta_{17,1} STRAIN_t + \alpha_{17,2} \sum_{i=0}^{2} GDP_{t-i} - GDP_{t-(i+1)}$$
$$+ \alpha_{17,3} \frac{DEFEX}{GDP}_t + \alpha_{17,4} \frac{MILMAN}{POP}_t + \alpha_{17,5}\left(\frac{GDP}{POP}\right)_t + \alpha_{17,6} TURMOIL_{t-1}$$

18. $$COUPS_t = \beta_{18,0} + \alpha_{18,1} \sum_{i=1}^{10} COUPS_{t-i} + \alpha_{18,2} \left(\frac{\sum_{i=0}^{2} (GDP_{t-1} - GDP_{t-(i+1)})}{\sum_{i=0}^{2} (POP_{t-1} - POP_{t-(i+1)})} \right)$$

$$+\alpha_{18,3} TURMOIL_t + \beta_{18,4} \left(\frac{\sum_{i=1}^{5} MILAID_{t-5}}{5} \right) + \alpha_{18,5} \left(\frac{GDP}{POP} \right)_{t-5}$$

19. $$CONFLICT_t = \beta_{19,0} + \alpha_{19,1} CONFLICT_{t-1} + \beta_{19,2} DEFEX_t + \alpha_{19,3} \left(\frac{DEFEX}{GDP} \right)_t$$

$$+\alpha_{19,4} TURMOIL_t + \alpha_{19,5} ALARMO_t + \alpha_{19,6} ALARMR_t$$

$$+\beta_{19,7} USCOOP_t + \beta_{19,8} SUCOOP_t$$

20. $$\left(\frac{DEFEX}{POP} \right)_t = \left(\beta_{20,0} + \alpha_{20,1} \frac{GDP_t}{POP_t} \right)$$

Where: $\frac{DEFEX}{POP}$ is the predicted value of

$\frac{DEFEX}{POP}$ when regressed on $\frac{GDP}{POP}$

21. $$TR_t = 100 * \frac{DEFEX}{DEFEX}$$

Equations for forecasting Trade with US

1. $$\Delta GNPUS_t = (1+c) GNPUS_t$$

2. $$\log IMPUS_t = \beta'_0 + \beta'_1 \text{ Log } GNPUS_t$$

APPENDIX 3

Variables, Years, Sources

APPENDIX 3

VARIABLE	ABBREVIATION	YEARS	SOURCE(S)
Population	POP	1960, 1965, 1970	ACDA World Military Expenditures & Arms Trade
Defense Spending	DEFEX	1960-1970	ACDA World Military Expenditures & Arms Trade
Arms Trade from US	USARMS	1963-1970	ACDA World Military Expenditures & Arms Trade
Arms Trade from USSR	SUARMS	(aggregated)	ACDA World Military Expenditures & Arms Trade
US Mil. Aid	USMILAID	1960-1970	Department of State
USSR Mil. Aid	SUMILAID	1960-1970	Department of State
Military Manpower	MILMAN	1964, 1965, 1969, 1970	ADCA World Military Expenditures & Arms Trade
US Aid	USAID	1965, 1970	Department of State
USSR Aid	SUAID	1965, 1970	Department of State
Gross Domestic Product	GDP	1960-1970	Collected from several sources including the UN Yearbook of National Accounts Statistics & the International Financial Statistics
Private Consumption (as % of GDP)	CONSUMP	1960-1970	UN Yearbook of National Accounts Statistics

VARIABLE	ABBREVIATION	YEARS	SOURCE(S)
Gross Fixed Domestic Capital Formation (as % of GDP)	INVEST	1960-1970	UN Yearbook of National Accounts Statistics
Total Imports	TIMPORT	1960-1970	IMF Direction of Trade Tape
Total Exports	TEXPORT	1960-1970	IMF Direction of Trade Tape
Imports from US	IMPUS	1960-1970	IMF Direction of Trade Tape
Exports to US	EXPUS	1960-1970	IMF Direction of Trade Tape
Dyadic Trade	TRADE (i,j)	1960-1970	IMF Direction of Trade Tape
Distance (between capital cites)	DISTANCE	1970	Calculated from longitude and latitudes of capital cities and a "great circle distance" program
UN votes with US	USVOT	1963, 1965	Annapolis Computer
UN votes with USSR (as % of all UN votes that US/USSR participated in respectively)	SUVOT	1969, 1970	Center Data Files
Total Trade with US	TRDUS	1964, 1965 1969, 1970	IMF Direction of Trade Tape
Total Trade with USSR	TRDSU	1964, 1965 1969, 1970	IMF Direction of Trade Tape
Bloc Membership	BLOC	1965, 1970	Recoded from Rummel & Don data +1 = US alliances, 0+neutral, -1 = USSR alliances)
Turmoil	TURMOIL	1964, 1965 1969, 1970	T.R. Gurr's Magnitude of Political Conflict Variance

VARIABLE	ABBREVIATION	YEARS	SOURCE(S)
Irregular Executive Transfers	COUPS	1955-1970	Banks, Cross Policy Time Series Data
Government Type I	GOVTYPE	1965, 1970	Coded by CACI (1=broad-based, popularly supported regime, 2=mixed regime, 3=new or traditional elitist regime)
Government Type II	GOVTYPE	1965, 1970	Banks, Cross Policy Time Series Data (1=civilian, 2=military-civilian, 3=military)
Physical Conflict	CONFLICT	1966-1972	WEIS file
Coercion	CONFLICT	1966-1972	WEIS file
Pressure	CONFLICT	1966-1972	WEIS file
Cooperative Behavior to US to i	USCOOP	1966-1972	WEIS file
Cooperative Behavior to USSR to i	SUCOOP	1966-1972	WEIS file
Composite Alignment	ALIGNR	See US/SUVOT, US/SUARM, US/SUTRD Variables	Average of three alignment intensities (ALVOTR, ALARMR, ALTRDR)
Alignment Instability	ALIGNS	See US/SUVOT US/SUARM, US/SUTRD Variables	Sum of aggregated differences between three alignment directions (ALVOTθ, ALARMθ, ALTRDθ)
Urbanization, literacy, % employed in non-agriculture, GDP	STRAIN	1965-1970	Compiled from various sources; UN, DON Project, AID etc.
US GDP	USGDP	1960-1970	UN Yearbook of National Accounts Statistics

VARIABLE	ABBREVIATION	YEARS	SOURCE(S)
USSR GDP	SUGDP	1960-1970	UN Yearbook of National Accounts Statistics
US Population	USPOP	1960-1970	UN Yearbook of National Accounts Statistics
USSR Population	SUPOP	1960-1970	UN Yearbook of National Accounts Statistics

BIBLIOGRAPHY

ABOLFATHI, F. (1975a) Military Expenditures in the Third World. Ph.D. dissertation, Department of Political Science, Northwestern University, Evanston, Illinois (forthcoming).

_____ (1975b) "Obstacles to the Quantitative Analysis of Public Expenditure Policies: The Case of Military Spending." Paper presented at the 16th Annual Meeting of the International Studies Association, Washington, D.C., February 19-22.

_____ (1975c) "Defense Expenditures in the Persian Gulf: Internal, Interstate, and International Factors in the Iraqi-Iranian Arms Race (1950-1967)." Arlington, Virginia: CACI, Inc.

_____ and T.W. PARK (1975) "Military Spending in the Third World: The Interactions of Domestic and International Forces," in C. Liske, W. Loehr, and J. McCamant (eds.) Comparative Public Policy: Issues, Theory, and Method. Beverly Hills, California: Sage Publications.

ALKER, H.R. and B.M. RUSSETT (1965) World Politics in the General Assembly. New Haven: Yale University Press.

ALMOND, G.A. and J.S. COLEMAN eds. (1960) The Politics of Developing Areas. Princeton: Princeton University Press.

AMES, B. (1975) "A Theory of Total Central Government Public Spending in Latin America." St. Louis: Washington University. (mimeo)

ANDERSON, C.W. (1967) Politics and Economic Change in Latin America. Princeton: D. Van Nostrand Co.

ARON, R. (1966) Peace and War. New York: Frederick A. Praeger.

BAERRENSEN, D.W., M. CARNOY and J. GRUNWALD (1965) Latin American Trade Patterns. Washington, D.C.: The Brookings Institute.

BEEDHAM, B. (1975) "Out of the Fire: Oil, the Gulf, and the West." The Economist 255, 6873 (May 17): Survey 1-92.

BEER, F.A. ed. (1970) Alliances: Latent War Communities in the Contemporary World. New York: Holt, Rinehart and Winston, Inc. .

BEN-DOR, G. (1975) "Civilization of Military Regimes in the Arab World," Armed Forces and Society I, 3 (Spring): 317-327.

BENOIT, E. (1973) Defense and Economic Growth. Lexington, Mass.: Lexington Books.

BERRY, J.A. (1972) "Oil and Soviet Policy in the Middle East," The Middle East Journal 26, 2 (Spring): 149-60.

BHAGWATI, J.N. ed. (1972) Economics and World Order. New York: The Macmillan Co.

BLONDEL, J. (1969) An Introduction to Comparative Government. New York: Praeger Publishers.

BREESE, G. (1966) Urbanization in Newly Developing Countries. Englewood Cliffs, N.J.: Prentice-Hall.

BROWN, G.S. (1975) United States Military Posture for FY 1976. Testimony before the U.S. Senate Armed Services Committee, Washington, D.C., February.

BURKE, F.G. (1964) Africa's Quest for Order. Englewood Cliffs, N.J.: Prentice-Hall.

BURRELL, R.M. and A.J. COTTRELL (1972) Iran, the Arabian Peninsula, and the Indian Ocean. New York: National Strategy Information Center, Inc.

BUSCH, P. (1971) "Appendix: Mathematical Models of Arms Races," in B.M. Russett, What Price Vigilance? The Burdens of National Defense. New Haven: Yale University Press.

CACI (1974) Quantitative Methods for Long-Range Environmental Forecasting: Long-Range European Projections. Arlington, Virginia: CACI, Inc.

_____ (1973) Quantitative Methods for Long-Range Environmental Forecasting. Interim Technical Report No. 2. Arlington, Virginia: CACI, Inc.

CAMPBELL, D.T. and D.W. FISKE (1959) "Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix," Psychological Bulletin 56.

CARTEY, W. and M. KELSON (1970) The Africa Reader: Independent Africa. New York: Vintage Books.

CHALMERS, D.A. ed. (1972) Changing Latin America. New York: Columbia University Press.

CIPOLLA, C.M. (1974) The Economic History of World Population. Baltimore, Maryland: Penguin Books.

COALE, A.J. (1974) "The History of the Human Population," Scientific American 231, 3 (September): 41-51.

COLE, J.P. (1965) Geography of World Affairs. Baltimore, Maryland: Penguin Books.

COOPER, C.A. and S.S. ALEXANDER, eds. (1971) Economic Development and Population Growth in the Middle East. New York: American Elsevier Publishing Company.

DABELKO, D. and J.M. MCCORMICK (1975) "Military vs. Social Welfare Expenditures: A Cross-National Analysis." Paper presented at the Annual Meeting of the International Studies Association, Washington, D.C., February 19-22.

DEMENY, P. (1974) "The Populations of Underdeveloped Countries," Scientific American 231, 3 (September): 149-159.

Department of State (1974) World Population Conference. Washington, D.C.: Government Printing Office.

_____ (1971) "Communist States and Developing Countries: Oil and Trade in 1970," Research Study. Washington, D.C.: Bureau of Intelligence and Research.

_____ (1966) "Communist Governments and Developing Nations: Aid and Trade in 1965," Research Memorandum. Washington, D.C.: Director of Intelligence and Research.

DEUTSCH, K.W. (1966) Nationalism and Social Communication: An Inquiry into the Foundations of Nationality. Cambridge, Mass.: The MIT Press.

DUNCAN, W.R. (ed.) (1972) Soviet Policy in Developing Countries. New York: Ginn and Company.

The Economist (1975) "Changes in Europe's Defence: Britain's Allies Will Be Spending More." (May 10): 64-65.

EL MALLAKH, R. (1970) Some Dimensions of the Middle East Oil: The Producing Countries and the United States. New York: American Arab Association for Commerce and Industry, Inc.

FERGUSON, Y.H. ed. (1972) Contemporary Inter-American Relations. Englewood Cliffs, N.J.: Prentice-Hall, Inc.

FERRIS, W.H. (1973) The Power Capabilities of Nation States. Lexington, Mass.: D.C. Heath and Co.

FINER, S.E. (1974) "The Man on Horseback--1974," Armed Forces and Society: An Interdisciplinary Journal.

FOSSUM, E. (1967) "Factors Influencing the Occurrence of Military Coups d'Etat in Latin America," Journal of Peace Research 3: 228-251.

FREEDMAN, R. and B. BERELSON (1974) "The Human Population," Scientific American 231, 3 (September): 31-39.

FORRESTER, J.W. (1971) World Dynamics. Cambridge, Mass.: Wright-Allen Press.

FRANK, A.G. (1967) Latin America: Underdevelopment or Revolution? New York: Monthly Review Press.

FURTADO, C. (1970) Economic Development of Latin America: A Survey from Colonial Times to the Cuban Revolution. Cambridge, England: Cambridge University Press.

GALTUNG, J. (1971) "A Structural Theory of Imperialism," Journal of Peace Research 2, 81-117.

_____ (1964) "A Structural Theory of Aggression," Journal of Peace Research II, 15-38.

GERMAN, F.C. (1960) "A Tentative Evaluation of World Power," The Journal of Conflict Resolution IV, 1 (March): 138-144.

GOLDHAMMER, H. (1972) The Foreign Powers in Latin America. Princeton: Princeton University Press.

GREEN, R.H. and A. SEIDMAN (1968) Unity or Poverty: The Economics of Pan-Africanism. Baltimore, Maryland: Penguin Books.

GURR, T.R. (1970) Why Men Rebel. Princeton: Princeton University Press.

_____ (1968) "A Causal Model of Civil Strife: A Comparative Analysis Using New Indices," American Political Science Review 62.

_____ and R. DUVALL (1972) "Civil Conflict in the 1960's: A Complete Theoretical System with Parameter Estimates," Northwestern University mimeo.

_____ and C. RUTTENBERG (1967) The Conditions of Civil Violence: First Tests of a Causal Model. Princeton, N.J.: Princeton University Press.

HANCE, W.A. (1970) Population, Migration, and Urbanization in Africa. New York: Columbia University Press.

HARRIS, W.D., JR. (1971) The Growth of Latin American Cities. Athens, Ohio: Ohio University Press.

HEINTZ, P. (1973) The Future of Development. Zurich: Hans Huber.

HEISS, K.P., K. KNORR, and O. MORGENSTERN (1973) Long Term Projections of Power: Political, Economic, and Military Forecasting. Cambridge, Mass.: Ballinger Publishing Co.

HIBBS, D.A. (1973) Mass Political Violence: A Cross-National Causal Analysis. New York: John Wiley and Sons.

HIRSCHMAN, A.O. (1958) The Strategy of Economic Development. New Haven: Yale University Press.

HOLSTI, O.R., P.T. HOPMANN, and J.D. SULLIVAN (1973) Unity and Disintegration in International Alliances: Comparative Studies. New York: John Wiley and Sons.

HOROWITZ, I.L. (1972) Three Worlds of Development. New York: Oxford University Press. 2d edition.

HODSON, H.V. (1972) The Diseconomics of Growth. New York: Ballantine Books.

HUNTER, R.E. and J.E. REILLY eds. (1972) Development Today. New York: Frederick A. Praeger.

HUREWITZ, J.C. (ed.) (1969a) Soviet-American Rivalry in the Middle East. New York: Praeger.

_____ (1969b) Middle East Politics: The Military Dimension. New York: Praeger.

HUNTINGTON, S.P. (1968) Political Order in Changing Societies. New Haven, Conn.: Yale University Press.

INTRILIGATOR, M.D. (1964) "Some Simple Models of Arms Races." Rand RM-3903-PR, Santa Monica, California: The Rand Corporation.

ISHI, H. (1974) "Long-Term Changes of the Government Saving Rate in Japan," Economic Development and Cultural Change 22, 4 (July): 616-633.

ISKANDAR, M. (1974) The Arab Oil Question. Beirut, Lebanon: Middle East Economic Consultants.

JANDA, K. (1971) "Conceptual Equivalence and Multiple Indicators in the Cross-National Analysis of Political Parties." Prepared for the Workshop on Indicators of National Development sponsored by ISSC UNESCO/ECPR, Lausanne, Switzerland, August 9-14.

JANOWITZ, M. (1964) The Military in the Political Development of New Nations. Chicago: University of Chicago Press.

JANSEN, G.H. (1966) Nonalignment and the New Afro-Asian States. New York: Frederick A. Praeger.

JENKINS, R. (1972) Exploitation: The World Power Structure and the Inequality of Nations. London: MacGibbon and Kee.

JOSHUA, W. (1971) Soviet Penetration into the Middle East. New York: National Strategy Information Center, Inc.

_____ and S.P. GILBERT (1969) Arms for the Third World: Soviet Military Aid Diplomacy. Baltimore: The Johns Hopkins Press.

KNORR, K. (1970) Military Power and Potential. Lexington, Mass.: D.C. Heath and Company.

KOCH, H.E., R.C. NORTH, and D.A. ZINNES (1960) "Some Theoretical Notes on Geography and International Conflict," The Journal of Conflict Resolution IV, 1 (March): 4-14.

KUZNETS, S. (1966) Modern Economic Growth: Rate, Structure, and Spread. New Haven: Yale University Press.

LEAVITT, M.R. (1971) A Computer Simulation of International Alliance Behavior. Unpublished Ph.D. dissertation, Department of Political Science, Northwestern University, Evanston, Illinois (June).

LI, R.P.Y. and W.R. THOMPSON (1975) "The 'Coup Contagion' Hypothesis," The Journal of Conflict Resolution XIX, 1 (March): 63-88.

LIEUWEN, E. (1965) Arms and Politics in Latin America. New York: Frederick A. Praeger.

LOMOR, N.A. (ed.) (1973) Scientific-Technical Progress and the Revolution in Military Affairs (A Soviet View). Moscow: Military Publishing House, Ministry of Defense of the U.S.S.R. (Translated and published under the auspices of the U.S. Air Force, Washington, D.C.: U.S. Government Printing Office.)

MADDISON, A. (1969) Economic Growth in Japan and the U.S.S.R. New York: W.W. Norton and Company.

McCLELLAND, C.A. (1966) Theory and the International System. New York: The Macmillan Company.

McGRANAHAN, D.V., C. RICHARD-PROUST, N.V. SOVANI and M. SUBRAMANIAN (1972) Contents and Measurement of Socioeconomic Development. New York: Frederick A. Praeger.

McILROY, J.J. (1974) Dependency, Development, and Third World Regionalism. Unpublished Ph.D. dissertation, University of Hawaii, Honolulu.

_____ (1971) "The Status Dimensions of Four Geo-Functional Regions." University of Hawaii, Honolulu, Hawaii.

MEADOWS, D.H., D.L. MEADOWS, J. RANDERS, and W.W. BEHRENS (1972) The Limits to Growth. New York: Universe Books.

MESAROVIC, M. and E. PESTEL (1974) Mankind at the Turning Point. New York: E.P. Dutton and Company.

MIDLARSKY, M.I. (1975) On War: Political Violence in the International System. New York: The Free Press.

_____ (1970) "Mathematical Models of Instability and a Theory of Diffusion," International Studies Quarterly 14, 1 (March): 60-84.

_____ and R. TANTER (1967) "Toward a Theory of Political Instability in Latin America," Journal of Peace Research 3: 209-227.

MILLWARD, R. (1971) Public Expenditure Economics: An Introductory Application of Welfare Economics. London: McGraw-Hill.

MITCHELL, W.C. (1927) Business Cycles: The Problem and Its Setting. New York: National Bureau of Economic Research.

MORGENTHAU, H.J. (1973) Politics Among Nations: The Struggle for Power and Peace. New York: Alfred A. Knopf.

MORLEY, J.W. (ed.) (1971) Dilemmas of Growth in Prewar Japan. Princeton, N.J.: Princeton University Press.

MYRDAL, G. (1968) Asian Drama: An Inquiry into the Poverty of Nations. New York: Pantheon-Random House.

NEEDLER, M.C. (1968) Political Development in Latin America: Instability, Violence, and Evolutionary Change. New York: Random House.

NEWCOMBE, A.G. (1975) "An Internation Tensiometer for Predicting War." Paper presented at the Annual Convention of the International Studies Association, Washington, D.C., February 19-22.

_____, J.D. BARBER, J. WERT, M. HAVEN, and C. HIEBERT (1974a) "An Improved Inter-Nation Tensiometer for the Prediction of War," Peace Research Reviews V.

NEWCOMBE, A.G., N.S. NEWCOMBE, and G. LANDLUS (1974b) "The Development of an Internation Tensiometer," International Interactions I.

NEWCOMBE, A.G. and J. WERT (1972a) An Inter-Nation Tensiometer for the Prediction of War. Dundas, Ontario: Canadian Peace Research Institute.

_____ (1972b) "The Prediction of War," Peace Research Society (International) Papers, The Philadelphia Conference.

NEWCOMBE, A.G. (1969) "Toward the Development of an Inter-Nation Tensiometer," Peace Research Society (International) Papers, Copenhagen Conference.

OLSON, M. and R. ZECKHAUSER (1970) "An Economic Theory of Alliances," in F.A. Beer (ed.) Alliances: Latent War Communities in the Contemporary World. New York: Holt, Rinehart, and Winston.

ORGANSKI, A.F.K. (1958) World Politics. New York: Alfred A. Knopf.

ORGANSKI, K. and A.F.K. ORGANSKI (1961) Population and World Power. New York: Alfred A. Knopf.

PARK, Tong-Whan and F. ABOLFATHI (1974) "The Origin and Consequences of Military Involvement in Defense and Foreign Policy," Journal of East and West Studies III (October): 3-49.

PETERS, G. (1972) "Economic and Political Effects on the Development of Social Expenditures in France, Sweden, and the United Kingdom," Midwest Journal of Political Science XVI, 2 (May): 225-238.

PETRAS, J. and M. ZEITLIN (1968) Latin America: Reform or Revolution? Greenwich, Conn.: Fawcett.

PRESSAT, R. (1970) Population. Baltimore: Penguin Books.

RAMAZANI, R.K. (1972) The Persian Gulf: Iran's Role. Charlottesville, Va.: University of Virginia Press.

REVELLE, R. (1974) "Food and Population," Scientific American 231, 3 (September): 161-170.

RICHARDSON, L.F. (1960a) Arms and Insecurity: A Mathematical Study of the Causes and Origins of War. Pittsburgh, Pa.: The Boxwood Press.

RICHARDSON, L.F. (1960b) Statistics of Deadly Quarrels. Pittsburgh, Pa.: The Boxwood Press.

ROSECRANCE, R. (1963) Action and Reaction in World Politics: International Systems in Perspective. Boston: Little, Brown, and Co.

ROSTOW, W.W. (1972) The Stages of Economic Growth. Cambridge: Cambridge University Press.

ROWE, E.T. (1974) "Aid and Coups d'Etat: Aspects of the Impact of American Military Assistance Programs in Less Developed Countries," International Studies Quarterly 18, 2 (June): 239-255.

RUBIN, T.J. and G.A. HILL (1973) Experiments in Scaling and Weighting of International Event Data. Arlington, Va.: CACI, Inc.

RUMMEL, R.J. (1972) Dimensions of Nations. Beverly Hills, Calif.: Sage Publications.

_____ (1968) "Dimensions of Conflict Behavior Within and Between Nations," General Systems Yearbook.

_____, San-Woo RHEE, J. OMEN, P. SYBINSKY (1975) National Attributes and Behavior: Data Dimensions, Linkages, and Groups, 1950-1965 (forthcoming).

RUSSETT, B. (1975) "The Americans' Retreat from World Power," Political Science Quarterly 90, 1 (Spring): 1-21.

SAFRAN, N. (1969) From War to War: The Arab Israeli Confrontation, 1948-1967. New York: Pegasus.

SANDLER, T. (1975) "The Economic Theory of Alliances: Realigned," in C. Liske, W. Loehr, and J. McCamant (eds.) Comparative Public Policy: Issues, Theories, and Methods. Beverly Hills, Calif.: Sage Publications.

SCHMITTER, P.C. (1973) "Foreign Military Assistance, National Military Spending and Military Rule in Latin America," in P.C. Schmitter (ed.) Military Rule in Latin America: Function, Consequences and Perspectives. Beverly Hills: Sage Publications.

SCHNEIDER, P.R. and A.L. SCHNEIDER (1971) "Social Mobilization, Political Institutions, and Political Violence: A Cross-National Analysis," Comparative Political Studies 4, 1 (April): 69-90.

SCOTT, R.E. (1973) Latin American Modernization Problems. Urbana, Ill.: University of Illinois Press.

SIMMEL, G. (1955) Conflict and the Web of Group-Affiliations. Glencoe, Ill.: The Free Press.

SINGER, J.D. (1972) "The Correlates of War Project: Interim Report and Rational," World Politics XXIV.

SIPRI (1971) The Arms Trade with the Third World. New York: Humanities Press.

SMOKER, P. (1965) "Trade, Defense, and the Richardson Theory of Arms Races: A Seven Nation Study," Journal of Peace Research.

_____ (1963) "A Pilot Study of the Present Arms Race," General Systems Yearbook 8.

SPROUT, H. and M. SPROUT (1968) "The Dilemma of Rising Demands and Insufficient Resources," World Politics XX, 4 (July): 660-693.

STALLINGS, B. (1972) "Economic Dependency in Africa and Latin America," Sage Professional Papers in Comparative Politics. Beverly Hills: Sage Publications.

SUNKEL, O. (1972) "Big Business and 'Dependencia:' A Latin American View," Foreign Affairs 50, 3.

SZYMANSKI, A. (1973) "Military Spending and Economic Stagnation," American Journal of Sociology 79, 1 (July): 1-14.

TAHTINEN, D. (1974) Arms in the Persian Gulf. Washington, D.C.: American Enterprise Institute.

TERRELL, L.M. (1972) "Patterns of International Involvement and International Violence," International Studies Quarterly.

THEBERGE, J.D. (1974) The Soviet Presence in Latin America. New York: Crane, Russak and Company.

TOMASEK, R. (ed.) (1966) Latin American Politics. New York: Anchor Books.

TRUESDELL, T. (1973) "World Event/Interaction Survey (WEIS) History and Codebook." Arlington, Va.: CACI, Inc.

WALLERSTEIN, I. (1969) Africa, the Politics of Unity. New York: Vintage Books.

_____ (1961) Africa, the Politics of Independence. New York: Vintage Books.

WANNACOTT, R. and T. WANNACOTT (1970) Econometrics. New York: John Wiley and Sons.

WARD, B. (1971) The Widening Gap. New York: Columbia University Press.

WEEDE, E. (1970) "Conflict Behavior of Nation-States," Journal of Peace Research 3.

WILKENFELD, J. (1973) "Domestic and Foreign Conflict," in J. Wilkenfeld (ed.) Conflict Behavior and Linkage Politics. New York: David McKay Company.

WOLFSON, M. (1968) "A Mathematical Model of the Cold War," Peace Research (International) Papers IX.

WRIGHT, Q. (1965) A Study of War. Chicago: The University of Chicago Press.

ZEITLIN, M. (1974) "On 'Military Spending and Economic Stagnation,'" American Journal of Sociology 79, 6 (May): 1452-1455.

ZINNES, D. and J. WILKENFELD (1971) "An Analysis of Foreign Conflict Behavior of Nations," in W. Hanreider (ed.) Comparative Foreign Policy: Theoretical Essays. New York: David McKay Company.